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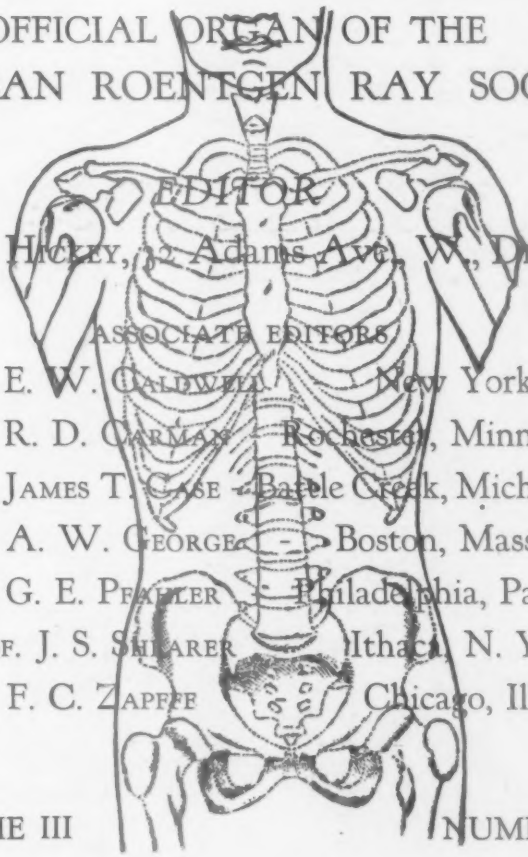

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THE AMERICAN JOURNAL OF ROENTGENOLOGY

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X-RAY IDIOSYNCRASY*

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VERY shortly after Roentgen's announcement of his discovery of the *x*-ray it was ascertained that this new agent possessed, from a therapeutic standpoint, both beneficial and injurious properties. It was soon found that it produced a peculiar dermatitis which might be of the acute or the chronic type. Further observation convinced the pioneers in this field that a radiodermatitis could be produced in any individual of any race or color if the dose were sufficiently large. Later still it was found that a certain amount of ray would be tolerated by the skin of one individual while apparently the same dose, when applied to another subject, would result in a more or less serious dermatitis. In the early days of *x*-ray work, when the technic was exceedingly inaccurate, cases of radiodermatitis were extremely common, both in roentgenography and roentgentherapy and it became the practice to place in the category of idiosyncrasy all the examples of unexpected reactions. But the more scientifically inclined observers were not satisfied with this explanation and they were able to materially lessen the number of reactions by a better knowledge of the science and art and by improvements in technic. For instance, one of the first advances in this line was the recognition and study of quality and quantity. It was discovered that the ray emitted from the *x*-ray tube was not homogeneous but very decidedly heterogeneous and that the rays of low penetration influenced the cutaneous covering of the body to a far greater extent than did the highly penetrating rays. It was not long before methods were devised to enable the operator to have at least some idea of both the quality and quantity of the ray administered—and with this improvement in technic there were fewer cases of radiodermatitis. It will be admitted, I think, by the older men, that not only have the number of cases of radiodermatitis decreased with increased experience, knowledge and development of technic, but that, as evolution has advanced, there has been a tendency to employ the term idiosyncrasy less frequently.

Even in experienced hands and with modern technic numerous examples of unex-

*Read at the winter meeting of Roentgenologists in Atlantic City, Jan. 22, 1916.

pected reactions have occurred within the last few years, but it is a notable fact that they are constantly growing less frequent. To-day it is more than uncommon, it is a rare occurrence for an unexpected reaction to occur when the operator is experienced in modern technic.

It is exceedingly interesting and instructive to review the literature with the subject of idiosyncrasy in mind. In England, for instance, in the early days of *x*-ray depilation for ringworm of the scalp, accidents were not uncommon. And great credit must be given to our foreign colleagues, both in England and on the Continent, for not following the path of least resistance, and blame these untoward results upon idiosyncrasy. They soon ascertained, by intensive study, that there were many errors in technic which, when corrected, markedly decreased the number of permanent alopecias. I can recall a number of bad results in England for which at first there was no explanation, but later it was discovered that the trouble was due to a tube of faulty construction used in connection with the half-distance method. Most of you are acquainted with the Hampson radiometer. When this instrument was placed on the market the directions were that the pastille was to be colored from zero to No. 6 in the treatment of ringworm of the scalp. This technic had given Hampson satisfactory results, but the dose was found to be too large in the hands of other workers, especially if they were inexperienced. The directions accompanying the radiometer were therefore changed and the epilation dose is now No. 4 instead of No. 6. In this country we have profited not only by our own experience, but by that of our foreign colleagues, and as a result we have been able, at Fordyce's Clinic, for instance, to successfully treat several hundred cases of ringworm of the scalp in the last three years without a single instance of erythema, or permanent alopecia. And this work has been conducted by four assistants, which, to some extent at least, speaks against personal equation being an important factor in this particular technic. The object of the foregoing remarks is simply to call attention to a fact that you all know—namely, that the untoward effects have decreased in proportion to experience and improvement in technic and that most of the former cases of radiodermatitis, instead of being due to idiosyncrasy as was formerly believed, were caused by errors of technic or of judgment, or of both, which were unavoidable at the time, but which are now, at least to a large extent, avoidable.

Now let us consider idiosyncrasy as we understand it to-day. In the first place we must have a uniform conception of the word itself. Susceptibility, hypersusceptibility, hypersensitiveness and idiosyncrasy are more or less synonymous. The first three nouns are absolutely so and they include idiosyncrasy, but idiosyncrasy does not necessarily include the others. As a comparison let us consider contagion and infection. A contagious disease is acquired by direct contact only, while an infectious disease may be contracted either by direct or indirect contact. I would limit the term idiosyncrasy to a susceptibility of unknown cause. Susceptibility would imply a hypersensitiveness of known or unknown cause. For a better understanding let us consider idiosyncrasy and hypersusceptibility as it is seen in dermatology and internal medicine. The bromides, the iodides and several other drugs will produce cutaneous eruptions in certain susceptible individuals. The reason for this is not known, therefore such patients have an idiosyncrasy. In the trades we frequently encounter examples of acute or chronic dermatitis resulting from the irritation of chemicals such as arsenic, mercury, volatile oils, photographic materials, varnishes, dyes, etc. Some individuals can handle these substances with impunity throughout their lives, while others finally acquire a susceptibility and further contact will produce a dermatitis. This acquired susceptibility is caused by the individual becoming sensitized just as in the case of the urticarial patient being sensitized to certain

food products such as oatmeal, egg albumen, etc. The point is that the susceptibility has been acquired and its chemistry is understood, so that it cannot be considered as an idiosyncrasy. In dermatology we have a disease known as xeroderma pigmentosum where there is an hereditary susceptibility to sunlight, with the production of freckles, teleangiectasia and malignant neoplasms. The susceptibility is not acquired and it is not understood, so it must be considered as an idiosyncrasy. This differentiation between idiosyncrasy and susceptibility, while only of academic interest, is exceedingly convenient, especially for the purposes of this article. With this definition in mind it will be manifest that the use of the term idiosyncrasy will become more and more restricted as our knowledge of the biological and biochemical properties of the *x*-ray increases. Many former instances of idiosyncrasy are now known to have been examples of acquired susceptibility. We know that the application to the skin of irritating chemicals such as iodine, chrysarobin, tar, mercury, pyrogallic acid, sulphur, iodoform, etc., markedly enhances the effect of the ray. I have seen a number of cases of erythema of the scalp, supposedly due to idiosyncrasy, that were caused by applications of iodine either before or after the use of the *x*-ray. The same is true, also, of eczema and psoriasis where chrysarobin, tar or mercury has been employed. I have seen the skin remain hypersensitive to the *x*-ray for months after the use of chrysarobin and iodine and areas of skin treated with large doses of *x*-ray may become very easily inflamed by strong chemicals months and even years later.

Certain diseases may produce a hypersusceptibility on the part of the skin. At times the skin in or over the lesions of mycosis fungoides will not tolerate more than H_2, B_{10} which is considerably less than the so-called epilating dose. I have, however, encountered examples of the disease where H_4, B_{10}, which is only one unit under the full epilating dose, would result in only a mild erythema. The normal skin in these susceptible cases does not react as vigorously as does that affected by the disease. This single fact speaks against idiosyncrasy as in true idiosyncrasy the entire cutaneous covering should be hypersensitive. The lesions of both psoriasis and eczema may be extremely sensitive, but in these cases it is possible that this susceptibility is caused by the previous or subsequent use of stimulating or irritating applications. I cannot recall an instance of hypersusceptibility in these diseases where no application other than the *x*-ray had been made. The skin over the thyroid in many cases of goiter appears to be hypersensitive, although this may be due to the location, for the skin of all the flexures is more sensitive than other parts of the body. In any event I am seldom able to apply more than H_4, B_{10} filtered through 3 mm. of aluminum to the skin over a goiter without producing an erythema and usually the dose is considerably less. Without entering into a further consideration of diseases and chemicals suffice it to say that they are known causes of acquired susceptibility.

The location of the body is another important factor. All the flexures—the anterior and lateral surfaces of the neck, especially the former, the axillae, the bend of the elbows and the popliteal spaces—are more susceptible than other portions of the body. The palms, the flexor surfaces of the wrists and the face are also quite sensitive. The abdomen appears to be more sensitive than the back, chest and extremities. The soles are fairly resistant. The scalp will stand larger doses than any other part of the body so far as concerns a radiodermatitis; especially is this so of the vertex. The age of the patient makes a difference. Aged individuals will tolerate much larger doses than will very young subjects. I have not noticed any particular difference in the susceptibility of the sexes—perhaps the female skin is a little more sensitive. Very dark skins do not seem to react as readily as do the lighter complexions.

Now there is another and very important

error in judging idiosyncrasy, namely, the time that is allowed to elapse between treatments. The skin that has once been treated is immediately more susceptible and this susceptibility in some of my cases has lasted for three or four months. And I have had some narrow escapes in such instances. I recall one instance where, fortunately, the patient disobeyed instructions and instead of returning for a second intensive treatment in four weeks, she did not come in until the end of six weeks. At this time there was a beginning erythema which became quite pronounced during the subsequent two weeks and which did not disappear until several weeks later. This was an instance of a delayed reaction of which I have seen a number of examples, and if the patient had received another treatment at the end of four weeks, at which time there was no erythema, a second or third degree radiodermatitis would have resulted. Another example was a man who had received two intensive treatments for a rebellious epithelioma. Both treatments were followed by an erythema which developed in about a week and which had entirely subsided in about a month. The second treatment was given seven weeks subsequent to the first application. A third application of the same amount was administered in three weeks when there was only a trace of erythema remaining. This was followed by a third-degree reaction that required nearly a year to heal. As a rule, a second treatment can be given in about four weeks subsequent to the first application, providing there has been no erythema or none has been present for a week, but it is much safer to allow a lapse of six or eight weeks after an erythematous dose in order to avoid the possibility of overlooking a delayed reaction and to allow the skin to lose its acquired susceptibility.

Another and frequent reason for error in judging idiosyncrasy is in faulty technic, which also includes errors in judgment and the personal equation. It is not within the province of this communication to discuss technic. Suffice it to say that the operator must be well acquainted, not only with the mechanics of the technic, but with every possible source of error. He should select his radiometer and learn its advantages and limitations. He should not rely on the radiometer alone, but on the ensemble or sum total of his technic. As an illustration a young man trained in Fordyce's clinic and doing admirable work began to have trouble, although, fortunately, not of a serious nature. On consulting the *X*-ray Staff at the Clinic it was found that the upper or colorless end of the colored celluloid band connected with the Holzknecht radiometer had assumed a yellowish-green tint, making the instrument quite useless. There are serious objections of this nature in connection with the Holzknecht radiometer which are entirely lacking in the Corbett instrument—but the latter instrument is by no means perfect. If the pastille method is utilized the pastilles must receive proper care and one should be able to tell whether or not his pastilles are in good condition. No matter what method of direct measurement is employed it should be controlled by every possible indirect means, but here, too, one must be well acquainted with all the possibilities. As an example, I would call attention to the resistance offered by bronze wire when used as a conductor for the low-tension current employed in connection with the Coolidge tube. This resistance will, of course, be modified by shifting the point of contact when the overhead system is used, which in turn will produce a modification in dosage. The question of quality is of the utmost importance because while H_4, B_{10} will produce an erythema, B_4, H_3, everything else being equal, will give rise to a second or third-degree radiodermatitis.

There are a number of peculiar effects produced by the *x*-ray that can be profitably discussed while considering the questions of idiosyncrasy and susceptibility. One has been already mentioned, namely, the delayed reaction to an erythema dose. I can offer no explanation for such delay and perhaps the phenomenon can be placed under idiosyn-

crasy. On the other hand, we know that circulation has a great deal to do with the effect of the ray. The sensitiveness of the skin to the *x*-ray is reduced by extreme anemia as, for instance, when the skin is dehematized by the Esmarch bandage or by adrenalin, and increased by congestion or hyperemia, which might account for the sensitiveness of the skin in some of the cutaneous inflammations. It may be, therefore, that the explanation of the delayed reaction is to be found in the local circulation, which circulation might have been deviated from the normal by the presence of a local disease.

Another peculiar condition is that which might be designated radioerythema persistans. Here we have an erythema developing in the normal length of time and consisting of average intensity, but which endures for several weeks or even months, instead of disappearing in a week or two. Then there are individuals who tan very readily, or the reverse—depigmentation; others who develop teleangiectasia or visible atrophy after a single erythema dose, either immediately or not until a year or two. I have examined histologically a great deal of tissue in such cases, but the histopathology, while explaining the genesis, fails to elucidate the reason for the occurrences only in certain individuals. It would seem then that these phenomena are due to inherent individual qualities and for the moment can only be explained by idiosyncrasy.

In ringworm of the scalp, where depilation has been accomplished, the hair usually falls out in three weeks and begins to regrow in three months. It generally grows slowly, steadily and equally over the entire scalp, and, as a rule, is of the same color, texture, etc., as the original hair. The exceptions are as follows: The hair may fall out in two weeks or not for four or five weeks. It may begin to regrow in six weeks or not until six months. The growth may be exceedingly vigorous or equally sluggish. It may grow more vigorously in some areas than in others. The new hair may be curly while the original hair was straight or vice versa. The new hair may be either lighter or darker than the original crop—also it may be coarser or finer. Now some of these phenomena can be explained by slight variations in the dose or by the effect of the disease, but some of them must be left unexplained. It is deemed unwise to depilate a second time until the lapse of six months in order to avoid permanent alopecia. While this is an exceedingly good rule, yet, as a paradox, I will relate the following experiment. An entire scalp was depilated without erythema by a modified Kienböck-Adamson method. The hair fell out in three weeks and began to regrow in three months. Four weeks later the hair which was growing very slowly but thickly was only about ½ inch in length. At this time three small areas were again depilated without erythema. The hair fell from these areas in the usual length of time, but began to grow again in two months. A few weeks later the hair in the areas that had been twice depilated was over an inch longer than the rest of the hair.

Now let us treat this question of idiosyncrasy in an enlightened manner, and not endeavor to shroud our untoward results in mystery and superstition. The statement is frequently made that there is an idiosyncrasy to practically everything, and therefore there must be an idiosyncrasy to the *x*-ray. There is some truth in this, but it is not very scientific. Personally, I have never had a case of unexpected radiodermatitis, or an untoward result, that I did not feel was caused by an error in technic, or in judgment. I do not mean to say that these errors were avoidable, as I employed the best technic available at the time and used the best judgment of which I was capable. The results were unexplainable at the time, but later, increased experience and knowledge explained the former errors. Some of the cases, for instance, were examples of acquired susceptibility from the use of drugs.

I do not wish to be misunderstood as expressing the belief that there is no idiosyn-

crasy to the *x*-ray. I cannot and do not exclude idiosyncrasy. While I, personally, in the treatment of many hundred cases, have never met with an instance of what I regard as an example of true idiosyncrasy, and while I am not willing to accept most of the reports of idiosyncrasy that come to me, nevertheless there are cases of apparently true idiosyncrasy in the literature and some of my local colleagues have encountered cases that seemingly cannot be placed under any other category.

If we include under idiosyncrasy acquired hypersusceptibility from known causes, then idiosyncrasy is common. If, on the other hand, we exclude from idiosyncrasy hypersusceptibility from known causes and avoidable or unavoidable errors in technic and judgment, then idiosyncrasy is uncommon—even of rare occurrence.

THE PHYSICAL ASPECT OF ROENTGEN RAY MEASUREMENT AND DOSAGE*

BY PROF. J. S. SHEARER, CORNELL UNIVERSITY, ITHACA, N. Y.

THE increasing use of roentgen radiation in the treatment of disease makes the careful study of the conditions governing its production and control a matter of prime importance. The rapid development of apparatus in recent years has scarcely left time for much needed investigation on the part of physicians and lack of familiarity with physical instruments and methods has resulted in some misconceptions and confusion. A brief survey of the purely physical features of this field may aid in systematizing procedure and give opportunity for suggestions.

Research on the origin of roentgen rays has shown that they are caused by either starting or stopping minute electrical particles, variously named cathode rays, β rays, corpuscles or electrons. Each electron is a definite charge of negative electricity whose physical characteristics are fixed by the electric charge. This charge is very small but never varies among the countless number involved in any electric action. The starting of electrons in motion by any known electrical apparatus does not change their speed suddenly enough to give us useful rays, when unstable atoms of radioactive bodies explode the starting out of electrons (β rays) results in the production of γ rays. When we give a high velocity to electrons by means of the electric field in a vacuum tube and they are *stopped* by a solid target their sudden change in velocity (deceleration) gives rise to roentgen rays. The higher the electron speed and the more effective the target material in quickly stopping them the more *penetrating* the resulting radiation. The *nature* and *amount* of the γ or roentgen radiation due to any single electron depends only on the *changes* in its speed. So that the amount and the quality of the beam (group of rays) depend on the aggregate action due to the group of electrons considered.

Electrons form a constituent of all atoms and they may vibrate while still bound to the atom. Such vibrations involve much more gradual velocity changes and give rise to light and to radiant heat. Or briefly stated, light and roentgen rays both arise from a disturbance of the electrical portion of atoms resulting in oscillation of electrons. The number of electrons participating and the extent of their disturbance fix in all cases the amount of radiation, that is, the quantity. The time required for the various groups of like moving electrons to make a single complete oscillation determines the character or quality of the radiation.

The only accurate measure of quantity of radiation is the heat developed on complete absorption, but this does not determine the usefulness of the radiation for any par-

*Paper read at the 16th Annual Meeting of the American Roentgen Ray Society, Atlantic City, September 22-25, 1915.

ticular purpose. The actual energy associated with a beam of *x*-rays is very small and at present we have little evidence that it is an important factor so far as therapeutics is concerned. The same amount of energy could be absorbed by tissue as heat or light without corresponding results. Yet the absorption of a *given type* of radiation doubtless determines its biological action.

The quality of radiation is more conveniently inferred from a consideration of the distance moved by the radiation during the time required to stop the exciting electron. This distance is named a *wave length* and as there are a great variety of electron speeds and of impacts on the coarse grained target, an enormous variety of wave lengths should be expected in the beam.

A great mass of evidence leads to the conclusion that roentgen, light and gamma rays are alike in origin and physical nature but differ greatly in wave length. The following table gives the approximate ranges of wave length in centimeters for the variously named rays:

Light $\frac{77}{1{,}000{,}000}$ (red) to $\frac{36}{1{,}000{,}000}$ (violet)

Ultra-violet $\frac{36}{1{,}000{,}000}$ to $\frac{6}{1{,}000{,}000}$

Roentgen $\frac{1}{100{,}000{,}000} \pm$

Gamma rays $\frac{1}{1{,}000{,}000{,}000} \pm$

[There are many longer or *soft* γ rays]

The roentgen waves average about fifty thousand times the radius of an electron, the gamma rays about five thousand times that radius. Roentgen rays have a wave length not far from the radius of the hydrogen atom.

Similarities between roentgen rays and light are numerous. They move through free space with the same velocities. Their intensities decrease at the same rate as we recede from the source. They are absorbed by various materials, and ultimately produce heat. They are scattered by matter and give rise in some cases to rays of generally increased wave length, the so-called fluorescent rays. They both cause electrical effects such as liberating electrons from certain surfaces, photographic action, photoelectrics, etc., and also cause certain chemical changes.

Roentgen rays are less absorbed by matter and are *changed* in direction at the surface of matter to a very much smaller extent than light. Only organized systems of atoms can show clear evidence of regular reflection to even a slight degree.

Roentgen and gamma rays both have the power to tear electrons from ordinary atoms thus producing β rays in gases, i. e., an ionizing effect. The most striking variation of behavior with wave length occurs in connection with absorption. While molecular state, chemical combination and temperature all modify light absorption, and while the shortest ultra-violet rays are absorbed by a thin layer of ordinary air, yet when the wave length is further reduced all materials become to a considerable degree transparent, and this transparency generally decreases with increased density and is quite independent of physical and chemical state.

The questions confronting the physicist in the field of radiation are how to determine:

(a) The quantity of radiation,
(b) The quality of the complex beam,
(c) The conditions controlling (a) and (b),
(d) The relation of quality to the specific effects desired in the use of the radiation,
(e) Further specific effects of the radiation and the real mode of action.

As regards quantity, we may totally absorb the radiation and find the heat resulting, or we measure the ionizing, photographic or chemical action. Generally the ionization chamber does not absorb even a large proportion of the rays and it is certainly not a convenient tool for a layman to use in measurment. Chemical actions are rare and slight. The photographic film absorbs only a small part of the passing *x*-radiation and it is hardly possible to infer differences in radiation received from variation in density of the developed plate, but

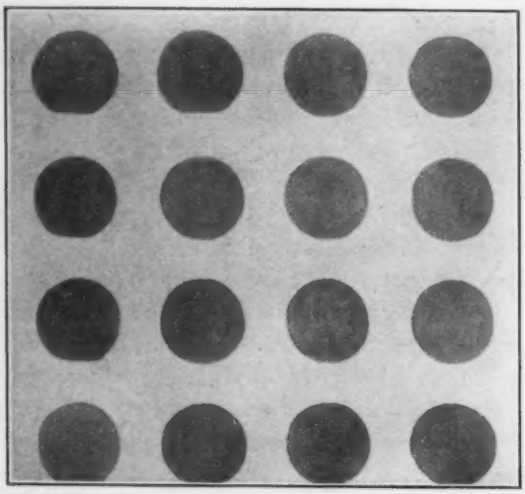


FIG. 1. A SERIES OF EXPOSURES MADE ON A SINGLE PLATE AT VARIOUS VOLTAGES [25 K.V. TO 60 K.V.], CURRENTS FROM 5 TO 50 MA., AND TIMES COMPUTED FOR EQUALITY OF DENSITY.

The 25 K.V. spot is weak on account of absorption of tube walls for this soft radiation.

we may regard *equal densities* on different parts of the same plate as implying equal absorptions.

Thus if a series of exposures are made on different portions of a photographic plate, and if these all show the same density on development, we are fairly justified in believing that equal amounts of effective energy were absorbed in the various regions. But if they differ in density we cannot readily determine the difference in received radiation from the observed darkening. Fig. 1 shows a series of such exposures where radical changes in tube current, consumed voltage and time were made in successive exposures. The aim was to keep

$$\frac{\text{Tube current} \times \text{Voltage} \times \text{Voltage} \times \text{Time}}{\text{Distance} \times \text{Distance}} = \frac{I\ V^2\ t}{d^2}$$

Where I = current in milliamperes
V = kilo-volts
t = seconds
d = distance

constant. (This was derived from theory by several observers but tests were only recently possible.)

The substantial uniformity of these densities shows that as far as the photographic effect is concerned, the radiation from a given outfit can be found by measurement of tube current, tube voltage, distance and time. The difficulty of comparing different outfits is due to the fact that during a single impulse through the tube both current and voltage take an infinite number of successive values. The instantaneous values may depend somewhat on type of transformer, control, length of rectifying sectors, gap between these sectors and the rotors. Yet these differences in result are very much less than one might expect. When milli-ammeter and e. s. voltmeter readings are carefully made the variation can hardly be detected.

The measurement of quality is also a matter of great difficulty. In light we can use a spectroscope sending different waves in different directions by a prism or grating. On account of the non-refrangible nature of *x*-rays the prism method is not available and no grating except the natural crystal atomic layers will serve. The latter will no doubt give an analysis as to wave

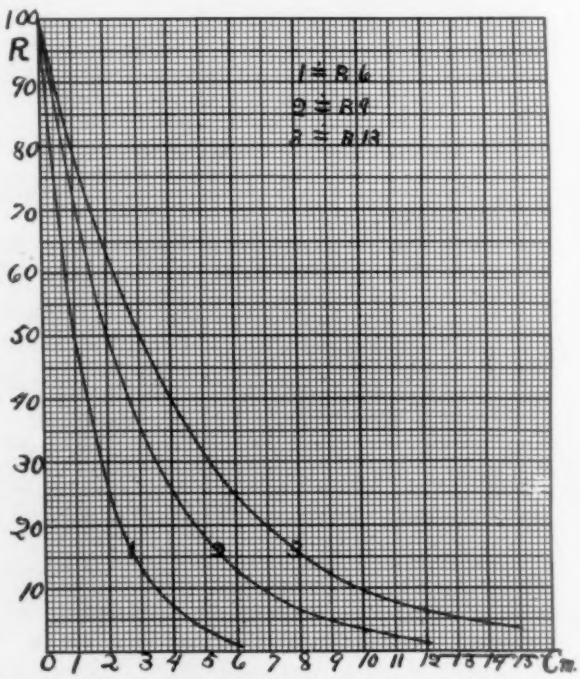


FIG. 2. DECREASE OF RADIATION OF DIFFERENT HALF VALUE LAYERS, ASSUMED TO BE HOMOGENEOUS.

length although such measurements are not yet at hand.*

Most of the present knowledge and methods of measurement are based on absorption. Imagine that our only study of light was by means of more or less muddy ordinary glasses and smoked glass, which is exactly our ordinary means of analysis of roentgen radiation. A photographic negative absorbs all colors in nearly like proportions, while a red glass reduces the intensity of the blue and green almost to nothing but allows red and usually some yellow to pass.

We may conveniently specify the action of any absorber for a *single wave* length by naming the thickness of a layer of the material that will reduce the radiation emerging to just one half that received. The first to make use of this method for roentgen rays was Christen, who named such

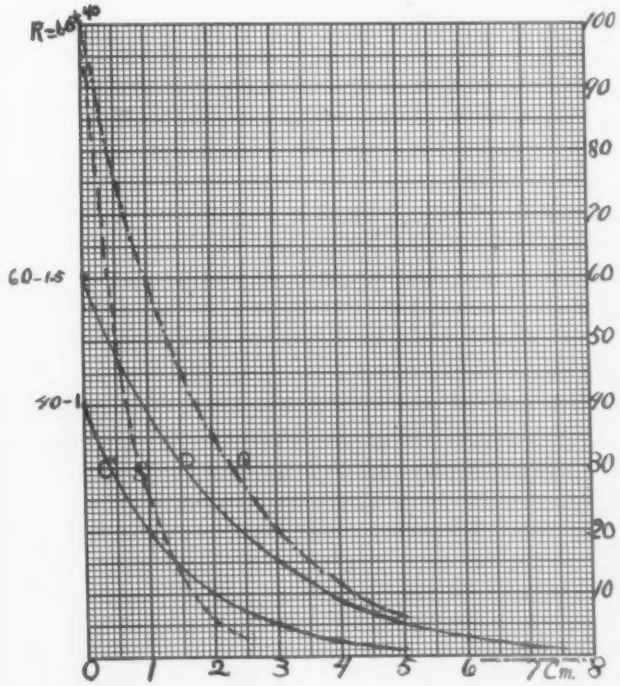


FIG. 3. COMPOSITE, TWO COMPONENT RADIATIONS.

C—40 units at surface, half value layer 1 cm. for selective absorber.

D—60 units at surface, 1.5 cm. half value layer for selective absorber.

S—Effect of a non-selective absorber, 5 mm. of which reduces each component to ½.

Q—Resultant of C and D.

*These results were reported by Dr. Hull at the meeting and have since been published in this Journal.

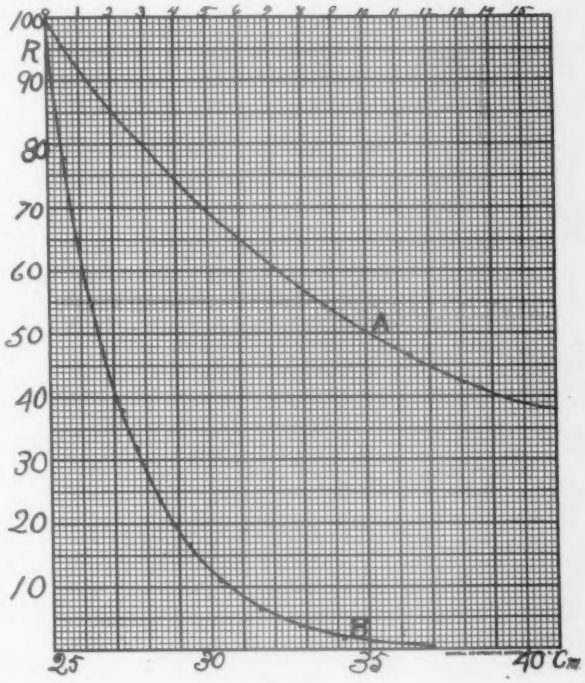


FIG. 4.

Curve A—Reduction by reason of distance from target 10 inches to 16 inches.

Curve B—Reduction by increased distance and absorption for a 2 cm. half value layer.

a thickness of water (or bakelite) *a half value layer for the radiation in question.* (These materials are chosen because their absorption is very similar to that of soft animal tissue.) Fig. 2 shows how *homogeneous* (single wave length) radiation falls off for successive half value layers. Thus if 1 cm. of water will reduce the incident radiation to ½, the amount passing 2 cm. is ¼, 3 cm. ⅛, 4 cm. 1/16, 5 cm. 1/32, etc., of the incident.

As a beam of roentgen rays is made up of a great mixture of wave lengths, some easily absorbed, others more penetrating, the amount transmitted through any layer as well as the amount absorbed by a layer at any depth depends on the *proportion* of *various penetrations* present.

When we use a penetrometer we determine a sort of average quality, serviceable, perhaps, but not at all an accurate measure. Fig. 3 shows the action of the Benoist penetrometer. Silver absorbs a

wide range of roentgen wave length at about the same rate, but aluminum is selective in its absorption. Suppose two beams having $D_{\frac{1}{4}}$ 1 cm. and 1.5 cm. respectively to fall on a selective absorber, and that 40 units of one and 60 of the other are incident on a non-selective absorber ($D_{\frac{1}{4}} = .5$ cm.), curves C and D show the decrease with thickness of the separate beams by selective absorption. Curve S shows the decrease of the total due to the non-selective absorber and Q shows the resultant of C and D. It is clear that 6 mm. of the non-selective absorber lets through the same total radiation as 15 mm. of the selective. If the amount of the higher penetrating radiation were increased, it would clearly take a greater thickness of the selective absorber to match a *fixed* thickness of the non-selective. In the Benoist and Wehnelt instruments, silver is the non-selective absorber and aluminum the selective.

The effect of increased distance of the various layers must also be considered in deep therapy. If the focus-skin distance is 10 inches (25 cm.) the reduction of radiation per unit area up to 15 inches due to increased distance is shown in Fig. 4, curve A. The other curve shows the falling off for a wave length having a half value layer of 2 cm. The former is the same for all wave lengths, the latter is specific.

Filtering through 3 mm. of aluminum makes the *apparent* hardness about two Benoist units higher than when unfiltered. *No rays are added by filtering, all are decreased,* but the amount of the softer components (long waves) are reduced much more than the harder (short waves). *The only gain from filtering is an increase of skin tolerance for a given deep dose.* Fig. 5 shows the effect of filtration and the difference between a change in current and in voltage. Column 1 was made at constant voltage, Column 2 at constant current, and in Column 3 both current and voltage were changed. Distance and time were the same for all of the radiographs.

If a certain photographic effect is produced in a given time, using a current I and a voltage V, the same darkening through the same material can be secured in less than ⅛ the time if both current and voltage can be doubled. Contrast, however, on the plate may be, and generally is, different.

We do not know as yet the relation between the amount of radiation absorbed and the biological effect. Very probably it is not in any simple or direct proportion. Yet all our evidence at present indicates that if there were *no* absorption no biological change would result and that rays might be of such a penetration as to have but little effect, i. e., when all are absorbed before reaching a lesion or when all pass through giving no effect on that.

Yet it is plainly unwise to assume that all the therapeutic action in a thin layer is due solely to absorption in that layer. The general circulation and the action on nerves must tend to distribute the action to other regions. We may thus be concerned more with the mean absorption for considerable thicknesses than would appear at present. We are also not fully informed as to what dose in any kind of units may be tolerated by flesh or organs below the skin. How can we be sure that an organ one inch below the surface, cross-fired so as to get 10X without exceeding 10X skin dose, will be properly treated for the result desired?

There is good reason to believe that a close analogy exists between the action of the rays on the photographic plate and their biological action. Both are no doubt due to ionization by β rays resulting from the destruction of roentgen rays in the film or tissue. And very probably their effect would be unnoticed, latent or dormant, were it not for development in the one case and cell building with biochemical action in the other.

It is interesting to observe that the destruction of roentgen rays results in the disruption of atomic structure with the production of liberated electrons [β rays] and positively charged residues *analogous* to α rays. Thus the action is finer grained

than chemical change and probably strongly modifies the forces placing atoms in the arrangement giving cell structure.

The amount of such destruction of roentgen rays determines the absorption. Christen has shown that if the *half value* layer is D and one side of the layer receives a radiation I, the amount absorbed by a layer A cm. thick (A small as compared with D) is .7 I × A/D. Thus a layer 1 mm. thick, of a substance in which the half value layer is 2 cm. receiving 100 units of radiation, would absorb 3.5 units; while for a radiation D = 1 cm., 7 per cent would be absorbed in the first millimeter. The maximum absorption for a thin layer *h* cm. below the surface for a given surface dose would be when the half value layer = .7 of the depth of the absorbing layer beneath the surface. (See Christen, "Messung und Dosierung der Roentgenstrahlen," pp. 103 and 104) or in round numbers if we could get a 1.75 cm. half value layer radiation it would give more absorption at 2.5 cm. (1 inch) depth than either a harder or a softer radiation *in proportion to the skin dose.*

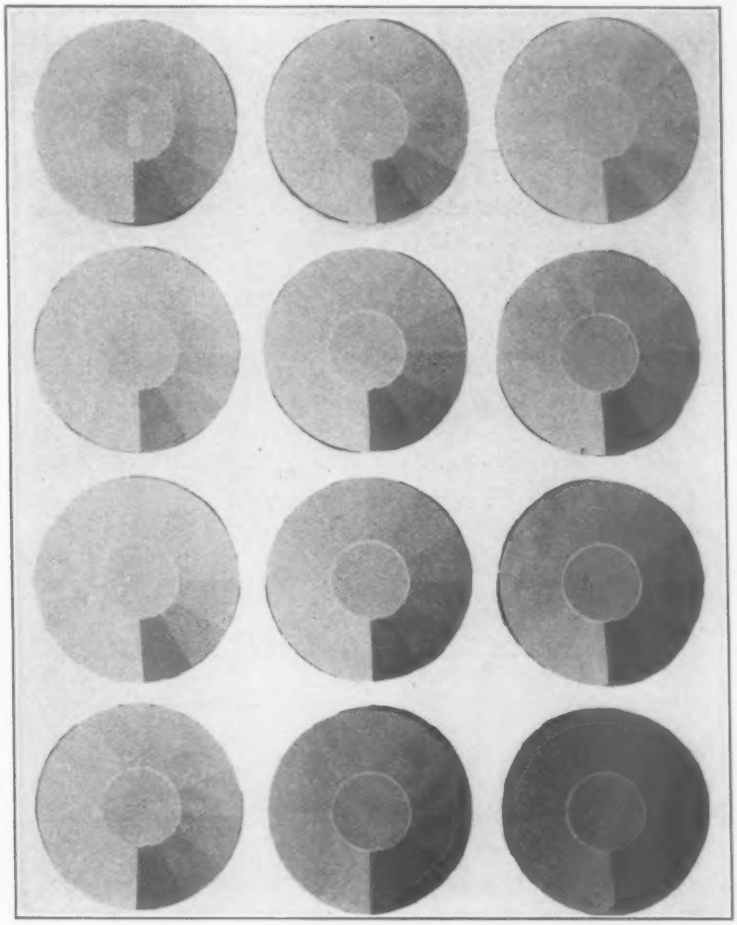


FIG. 5.

Distance 24 inches, time 5–10 second.

Left Column	*Middle Column*	*Right Column*
30 K.V. 30 Ma.	30 K.V. 30 Ma.	30 Ma. 30 K.V.
30 " 40 "	40 " 30 "	40 " 40 "
30 " 50 "	50 " 30 "	50 " 50 "
30 " 60 "	60 " 30 "	60 " 60 "

The question of any specific action of

waves of a particular length may be raised and certainly should be investigated by the use of homogeneous beams such as can be attained by filtered "characteristic" rays. That there should be any marked difference for *equal amounts absorbed* does not seem probable and yet trial should be made when opportunity offers. Whether it is possible to sensitize tissue either by introducing material to increase the absorption and to produce characteristic rays or to aid in the after action of the rays by rise in temperature or by modified blood is well worth careful study.

In order that the clinical results obtained by various observers should be capable of comparison and that the dosage reported to give favorable results may be duplicated some means of comparison must be generally adopted. In the writer's experience the use of pastilles and Kienböck strips is not all that might be desired. The former are not easy to read, must be placed with great care and are affected by light and variable humidity. The Kienböck seems to work better with most observers and has the advantage of giving a fairly permanent record of the dose. Errors in timing development, in securing correct temperature and difficulty in reading the higher portion of the scale make great care necessary for reliable results.

In this connection it may be interesting to note that the law of radiation here outlined agrees quite well with the results for unfiltered radiation published by Pfahler in the March issue of this Journal. Experiment 5, p. 677, of that article, gives his readings for constant current, time and distance but variable spark gap.

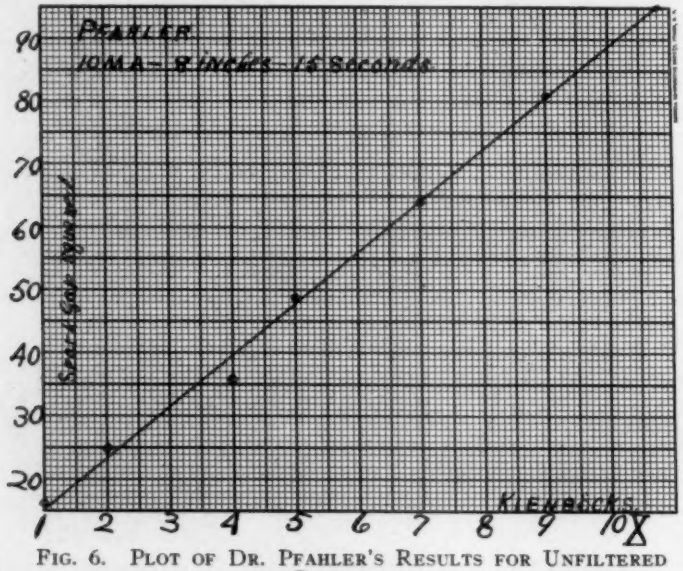


FIG. 6. PLOT OF DR. PFAHLER'S RESULTS FOR UNFILTERED RADIATION.

Squares of spark gap and Kienböck units. 10 Ma.—8 inches—15 seconds.

If we construct a diagram using as base lines X readings and as verticals *squares* of *spark gaps* we get the points marked in Fig. 6. By a well-known mathematical method we can get the equation of the most probable straight line through these points. Since 10X is hard to read and this point is not as consistent with a linear arrangement as the others, the full line is drawn as the most probable for points 1X to 9X. Its equation is $y = 8.1X + 7.5$, or $[\text{spark gap}]^2 = 8.1 \times \text{Kienböck} + 7.5$ when the current was 10 ma., the target-paper distance 8 inches and the time 15 seconds. Otherwise expressed Dr. Pfahler can predetermine his X dose for any current or dis-

tance at a *selected* spark gap from this line more closely than he can read a single strip.

Taking Fig. 6 as a basis, a scale for spark gap and X units may be constructed. Fig. 7 shows the result in Dr. Pfahler's case where we have 10 Ma., 8-inch target film distance, 15 seconds exposure. For 5 Ma. we may double the exposure, and for 5 Ma. and 10-inch strip-target distance 47 seconds would give the same result.

A careful test at 10 inches, 5 Ma. for 3X and for 5X at 5 and 7-inch gaps checked most reliable means of determining the amount of roentgen radiation delivered is to measure voltage, current through the tube, distance and time. Our measurements show that even with an ordinary spark gap measure of voltage, an accuracy of reproduction can be attained quite beyond the range of variation possible of detection with pastilles or papers.

The radiation from the Coolidge tube operated under constant conditions can be standardized for any given transformer so

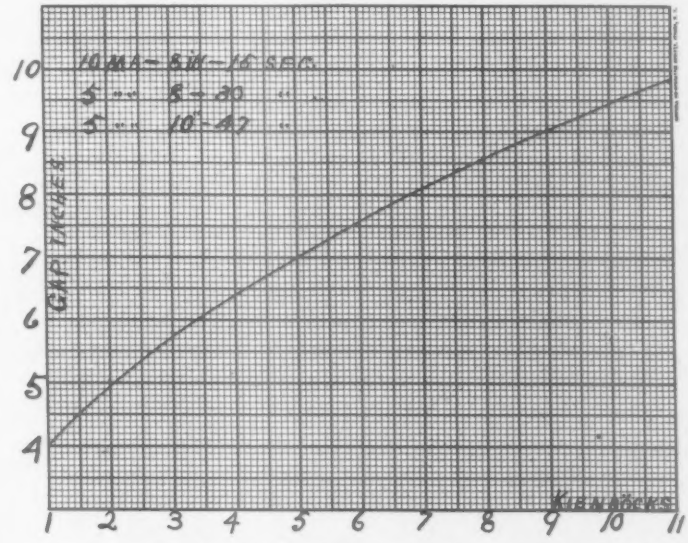


FIG. 7. DR. PFAHLER'S RESULTS, SHOWING THE RELATION BETWEEN SPARK GAP AND KIENBÖCK UNITS.
10 Ma.—8 inches—15 seconds.

with the standard Kienböck scale as closely as one can readily read.

In the measurement of dose by the use of Kienböck's, one must not forget that it is very difficult to distinguish the darker tints, say 9X from 10X, and even in the lower part of the scale one would hardly venture to read with certainty 3¼X for example. Perhaps all that is required is to keep the dose within some rather liberal limits. Yet it may appear that these limits must be reduced as more information is at hand and our means of following physical conditions are improved.

Many observations during the last two years have convinced the writer that the that *tube current, primary voltage, distance* and *time* will absolutely fix the radiation. There is no more reason for *ultimately* having to use strips or pastilles than that one should have a photometer to test one's own lamps.

One might have a calibration showing that on a 60 cycle current, 150 applied volts and a tube current of 5 Ma. the time for 10X at 10 inches is 45 seconds, without filter: at 170 applied volts and the same current a different time would be required. The number of K.V. consumed by the tube for a *given tube current* and *primary* voltage on the *same* transformer is constant. Hence if a reliable control rheostat is used

or a good autotransformer there will always be the same voltage consumed by the tube for the same tube current and *control* setting. Thus on a particular outfit recently used in the writer's laboratory a tube current of 5 Ma., rheostat button 7, gives 75 K.V. (E. S. voltmeter reading or 10-inch dull point spark) repeatedly. Under these conditions an exposure of a definite number of seconds gives say 2X, and 5 times this exposure gives 10X, etc. Having this information I no longer really need the voltmeter or spark gap so far as unfiltered dosage is concerned. A similar determination can be made with filtration through various thicknesses of aluminum. This enables predetermination of dose while otherwise one often doses first and measures afterward. If a record is desired a strip of standard paper can be exposed for a measured interval and developed later.

Where a large amount of treatment is to be undertaken, there should be developed and installed time recorders showing the current, time and primary voltage while a chart will give the secondary voltage. If transformers are developed for kenetron valve operation it may be quite possible to operate several tubes at once from one transformer under standard conditions.

It may be urged that transformers differ as to the radiation produced. It is the

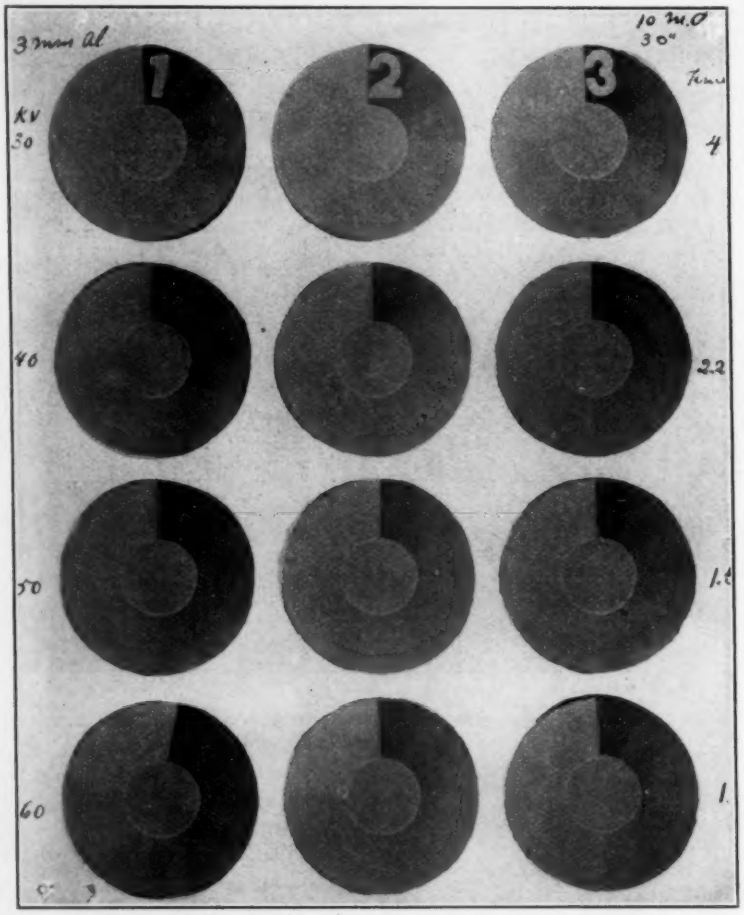


FIG. 8.

Left *column* made with machine No. 1, etc. Each *row* was made at the same voltage, current, distance and time.

writer's belief that when a tube is operated at a given current and voltage (not spark gap, *see note*), the variation between different machines able to give the operating conditions required (say 5 Ma. and 75 K.V.) is quite beyond discovery by Kienböck strips. Fig. 8 shows a plate in which Column 1 was made with an old machine

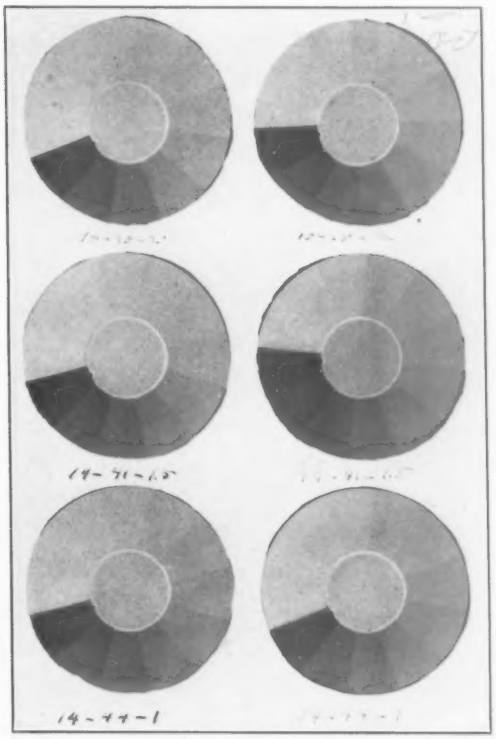


FIG. 9. KENOTRON OPERATION AT SAME TUBE CURRENT, VOLTAGE, DISTANCE AND TIME AS ON A MECHANICAL RECTIFIER.

Left column, rectifier. Right column, kenotron.

of low current capacity, 2 with a modern high power closed magnetic circuit transformer, 3 with an open magnetic circuit of recent design. Care was taken to have tube *current, voltage, time* and *distance* the same for exposures on the same horizontal row. Fig. 9 shows exposures with one of these transformers run with a kenetron compared with the usual rectification.

The reason for this agreement is clear when one considers the predominant effect of the current delivered at the higher voltages. While the tube drop is below 20 K.V. only a relatively small *amount* of non-penetrating radiation is *produced*. Fig. 10 shows this variation with voltage for one half a sine wave pulse. Assuming 100 units of radiation per Ma. at 100 K.V. peak voltage, then at 50 K. V. only 13 are given, at 75 K.V. 45 units, etc. In fact about 3/5 of the entire radiation is emitted when the voltage is between the peak and 10 per cent. of

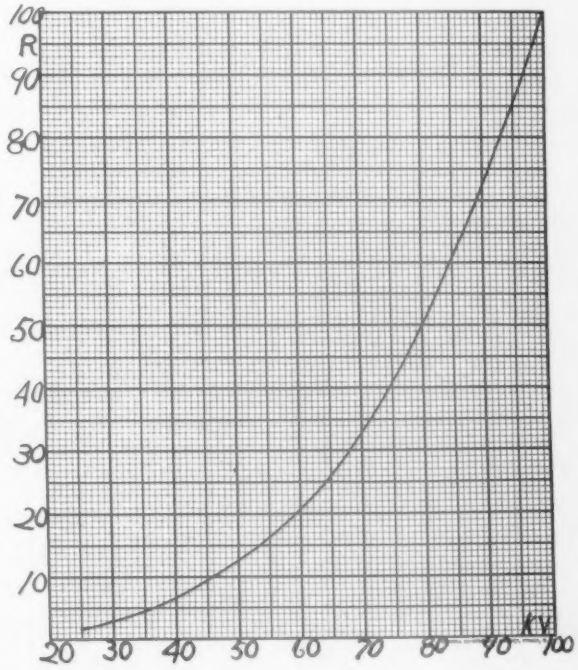


FIG. 10. ROENTGEN RAY PRODUCTION ON A SINE WAVE AS INDICATED BY V^2 LAW.

Shows relative values at various voltages.

the peak voltage. Also that at low voltage is reduced by glass absorption. A study of the oscillograph records of tube currents shows that there is little variation in this portion of the wave delivered by the various machines. It would then seem quite possible to do good therapeutic work with transformers now in use and to determine with care once for all what number of X units are received at 10-inch distance per minute on such buttons as will give say 7, 8, 9 and 10 inches equivalent spark gap when using

5 Ma. through the tube. A standard paper may then be exposed for such a fraction of the total time as will keep its shade within the region of greatest sensitiveness and this may serve as a record.

Support should be secured for the continued investigation of the effects of filtering, of homogeneous rays and all the physical and biological effects of both roentgen and radium rays. Surely no research is more worthy of financial support or moral encouragement than that whose results in the past promises so much for the future.

NOTE.—The observations cited above were all taken with the voltmeter and no attention was paid to spark gap. Inasmuch as most work is cited in terms of spark gap measurement of voltage it seemed desirable to check the results in this way. Using Sabauroud pastilles it was found that on an open magnetic circuit transformer the *time* required with the same spark gap setting, all other conditions being the same, was about 33 per cent. greater than with the closed magnetic circuit type. A careful comparison of spark gap and voltmeter readings for the two machines showed that the *voltmeter* reading was very closely *15 per cent. higher for the same gap* on the closed circuit than on the open. The ratio of the radiations would then be $\frac{(1.15)^2}{1} = 1.32$. Hence for the same spark gap setting one of these machines will give an erythema dose in 3 minutes, the other in 4, while on the same voltmeter reading the times are so nearly alike that the difference is not readable on the usual tests. We could not compare open circuit machines one with another as only one was available and it does not follow that such a transformer is unsuitable for treatment but only that it must *not* be rated by spark gap readings from other types even when the gaps are of like construction.

Summarizing, we find that there is a very close agreement in the pastille or Kienböck readings of all types of transformer when a *reliable* voltmeter is used. (It must not be assumed that any instrument mounted with a scale marked Kilo Volts is reliable; most of them vary tremendously with the current the tube is taking.) While it is not safe to use spark gap data from one machine to another unless the same type of transformer and gap is used, a machine may be calibrated with either pastilles or Kienböcks, preferably with both, so that the skin dose per minute on a given control setting, distance and tube current may be known if the primary voltage is reasonably constant. When this is carefully done the Kienböck or pastille becomes an additional check on the total dose or on a suitable partial dose.

THE VALUE OF THE LATERAL VIEW OF THE HIP

BY P. M. HICKEY, M.D., DETROIT, MICH.

THE examination of the stereoscopic plates of the hip is usually satisfactory, but the necessity often arises where even stereoscopic plates do not give all the information desired as to the pathology present.

The writer has tried a number of procedures in an attempt to bring out some of the points which are obscure in the ordinary antero-posterior exposures. We, accordingly, have adopted as precautionary measures, the following technique to supplement the usual antero-posterior plates of the hip: The patient lies upon the side to be examined, the thigh is flexed until it forms a right angle with the long axis of the body. The plate is placed under the affected side and the rays directed from above downward, with the tube in front of the patient, so that the central rays are forming an angle

FIG. 1. ANTEROPOSTERIOR VIEW, SHOWING AN INDEFINITE ABSORPTION OF THE UPPER END OF THE FEMUR, JUST BELOW THE INTERTROCHANTERIC LINE.

FIG. 2. PLATE MADE OF THE HIP IN THE LATERAL POSITION DESCRIBED IN THE TEXT, WHICH SHOWS A SHARPLY DEFINED AREA OF BONE ABSORPTION.

Operation revealed a soft fibroma, almost gelatiniform in consistency, non-sarcomatous in nature.

of twenty to twenty-five degrees passing through the greater trochanter. The patient's back is supported by long sand-bags and the patient's femur under examination is immobilized by other sand-bags. The other leg is preferably raised from the table and supported in an easy position by pillows. This technique cannot be employed in cases where the pain or disability prevents the flexion of the femur. It has, however, marked value in a certain number of selected cases.

One of the first cases which was employed was in the study of a boy's hip where, after recent injury, tuberculosis was suspected; here a lateral view of the upper end of the femur showed periostitis upon the posterior aspect of the upper end of the femur. This periosteal change could not be seen in the stereoscopic plates made in the anteroposterior position. Accordingly, the diagnosis of osteomyelitis was made and was checked up by the operative procedure.

The second case which we throw on the screen was an early rarefaction of the upper end of the femur with marked symptoms of sciatica. The stereoscopic plates showed an irregular thinning concerning which the diagnosis was somewhat obscure. The lateral view, however, which we throw upon the screen shows a very definite destruction of the medullary canal by what was thought to be a bone cyst. An operation revealed a soft fibroma definitely circumscribed which was removed with a complete recovery.

We would repeat again that we are not presenting this technique with the idea that it can be universally applied to all cases of examination of the hip, but there are certain isolated cases where it undoubtedly would be found to be of extreme value.

THE CAUSE AND PREVENTION OF THE CONSTITUTIONAL EFFECTS ASSOCIATED WITH THE MASSIVE DOSES OF DEEP ROENTGENTHERAPY *

BY GEORGE E. PFAHLER, M.D.

PROFESSOR OF ROENTGENOLOGY IN THE MEDICO-CHIRURGICAL COLLEGE OF PHILADELPHIA

WHEN this title was sent in to the Program Committee, I had hoped to be able to solve this problem. In this I have not been entirely successful. I feel, however, that no more important subject can be brought before this meeting, for with the increase in the use of the massive dose treatment, which I am sure is the correct method, we must, at the same time, find some method of eliminating the disagreeable constitutional effects, and I am hoping that my observations will be supplemented by those of other members so that we will together be able to solve this problem.

Constitutional Effects.—These consist for the most part of nausea and sometimes vomiting. Rarely these symptoms appear before the patient leaves the office. Generally they begin within a half hour to an hour. Generally they last only during the remainder of the day and disappear the following morning. Occasionally they persist over several days, and when added to by other prostrating influences in one or two cases they seem to have continued to a slight extent for as long as two weeks. Associated with the nausea and vomiting, there is more or less prostration, and in a few instances the patients have felt faint. One patient leaned up against a building to keep from falling. This occurred in the case of a lady physician who was not especially alarmed and did not call for any special assistance. In her case, this faintness occurred about a half hour after cessation of the treatment and about fifteen minutes after leaving the office. At the time of leaving the office she felt well. It was one of my early experiences in this line, and at the time I believed it was not associated with the treatment. A few patients have complained of headache.

Theory as to Cause.—I am working rather uniformly with a 9-inch parallel spark, and with a transformer. Under these circumstances, there is a great deal of brushing into the air of this high tension electricity both from the transformer and from the wires leading to the tube. This produces a disagreeable smelling gas which is recognized very plainly when one comes into an *x*-ray laboratory after a Coolidge tube has been in use for a considerable time. This odor is recognizable even with thorough ventilation and can be recognized sometimes hours after cessation of treatment. This odor has been spoken of and complained about by patients even before the advent of the Coolidge tube, and even when these constitutional effects were not noticed, some patients said that it took a week for the odor to leave their hair. It occurred especially in connection with my 24-48 plate high speed static machine. It is, of course, very much more marked since the advent of the Coolidge tube which permits the use of larger currents and the development of a larger quantity of rays in a shorter period of time, and the multiplication of doses by our more modern crossfire methods increases these effects on the air to a marked extent. I believe, therefore, that one of the main factors causing these symptoms is the gases produced by the action of the high tension current on the air. To this may possibly be added the ionization effects

* Read before the American Roentgen Ray Society, 16th Annual Meeting, Atlantic City, September 22-25, 1915.

of the rays upon the air. In addition, there must be some fitting condition of the patient which renders the patient sensitive to these effects, for with two patients treated in the same room, during the same length of time, one will develop symptoms and the other will be absolutely free. This has led me to believe that it is the more highly sensitive and neurotic type of patient that is liable to develop these symptoms, and yet the same patient will develop symptoms on one day and after another course of similar treatment at another time show no symptoms. It is these variations that make me feel that we have not yet solved the problem. Originally it was thought to be due to the effect of the rays on the ovaries because these symptoms had developed particularly in gynecological cases. This is not true, however, for I have seen the same effects in men, and I find it equal or more frequent in women whom I have treated for carcinoma of the breast. It has been thought too that these symptoms may be due to the effects of the rays on the general tissues of the body, but it seems to me that the symptoms come on too soon and are too transient to be due to tissue changes. These symptoms seem to develop in about one-fourth of the patients treated. If they were due to constitutional effects of the rays on the tissues, it seems to me that they would affect a greater proportion of the patients.

Prevention and Treatment.—This of course depends upon the cause, and until we have definitely determined the cause it will be impossible to reduce our methods to a rational prophylaxis or treatment. Since the most likely cause is the chemical and odoriferous disturbances in the composition of the air, the rational line of treatment will be first to eliminate the gases so far as is possible, and second to provide air as fresh as possible for the patient to breathe.

Methods of Eliminating Gases.—The prevention of leakage of current from every point possible by careful insulation either about the machine, leaking points on the machine, but more particularly by eliminating leakage along the wires which can be done by means of the heavy cables or by suggestions made by Prof. Shearer.* The gases developing immediately about the tube can be eliminated by the method invented by Dr. Caldwell, which consists in enclosing the tube by an airtight insulated and opaque casing from which the gases are removed by a suction apparatus which, at the same time, removes a certain quantity of the air and gas from the room.

Methods of Supplying Fresh Air to the Patient.—This can be accomplished first by giving the treatment in a large well-ventilated room which permits of considerable air space. This, however, would only be efficient when there was sufficient current of air to remove the gases from about the patient, for the patient is near the source of these gases, and unless they are forcibly removed, the patient will not only breathe them, but rebreathe them. Toward this end I have installed a number of fans so placed as to force a fresh current of air over the head of the patient, and so far as possible carry the gases in an opposite direction. This arrangement of fans and currents of air cannot be reduced to mathematics, for the direction of the current of air depends not only upon the force of the fans, but upon the force of countercurrents, and it is very easy to get a patient's head in an eddy of air currents which would have entirely the effects of still air. The actual direction of the currents, however, can be easily determined by the use of a paper napkin held by one edge which is moved easily by the slightest current of air, and I commonly find that the movement of the patient 3 to 6 inches will make a difference between breathing fresh air and breathing the gases directly from the wires, for the direction of the countercurrents depends upon the direction of the wind outside, the position of an open window or the opening of a door somewhere in the building. I am sure that by careful direction of air currents and

* American Quarterly of Roentgenology.

the supplying of fresh air, I have eliminated a great part of these constitutional effects. I believe too that the irregularities in the patient's symptoms which permit them to develop in one day and not in another may be due to the fact that during the course of treatment some outside influence has made a change in the countercurrents, and thus permitted a patient to breathe these obnoxious gases at a time when I felt that they were receiving only pure air. This can be further provided against by making the paper napkin test several times during the treatment.

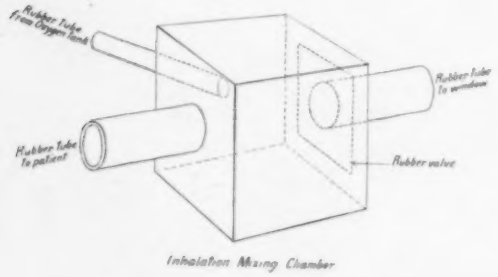


FIG. 1. INHALATION MIXING CHAMBER OF APPARATUS FOR SUPPLYING FRESH AIR AND OXYGEN DIRECTLY TO THE PATIENT.

FIG. 2. THE BREATHING MASK.

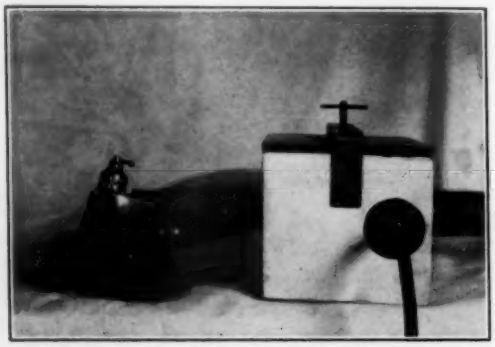


FIG. 3. BREATHING MASK AND INHALATION MIXING CHAMBER, SHOWING CONNECTING TUBES.

FIG. 4. APPARATUS IN POSITION, SHOWING CONNECTIONS.

Apparatus for Supplying Fresh Air and Oxygen Directly to the Patient.—For this purpose I have invented a simple little device which works, and which seems to be a distinct step in advance. It consists of a breathing mask for the nose and mouth made of celluloid with rubber cap to form the contact with the face, such as is used with the nitrous oxide and ether apparatus. I removed the metal cap from the top, however, and inserted a rubber tubing at one end so that it would be less bulky for the patient to hold. This contains a valve at the top which permits the egress of expired air, but not the ingress of the air from the room. The rubber tubing extends to and outside of the window so as to take the air from outside of the building. In this

fresh air circuit I have introduced an inhalation mixing chamber which I have designed. It consists of a cubical box, 5 x 5 x 5, with brass tubes inserted at two opposing ends. To one of these is attached the rubber tubing which extends outside the building, this rubber tubing having an inside diameter of ¾ inch. At the inside of this end of the box, a valve is produced by attaching a sheet of thin rubber 2 inches square. The top edge of this is held fast by means of adhesive plaster. This permits the ingress of air, but not the egress. At the opposite end of the box there is a brass tubing for the attachment of the rubber tubing ¾ inch inside diameter which leads to the patient. At another side is attached a small rubber tubing which is connected with an oxygen tank. This permits the mixture of oxygen and air before the patient breathes it. For convenience of watching the action of the valve, and for the purpose of introducing any perfumes that we feel are necessary, we have made the top of this box of glass, held in place by a clamp. (Figs. 1-4.)

To Overcome the Odor.—We have found some benefit from spraying the pillow with perfume. This seems to have helped some with the patients before we made use of the mixing chamber.

Dividing Each Series.—We have come to believe that with a large series of doses which must be given that it is some advantage in dividing the treatment, and giving part of it on two or three successive days. It is a disadvantage to let a longer interval pass because of the difficulty of keeping the marks on the skin which divide the areas of skin or portals of entry. When a patient comes from a distant point we sometimes give part of the treatment in the morning and part in the afternoon, and even this seems to be some advantage, or sometimes part of the treatment can be given in the afternoon and finished on the following morning. We have even found some advantage in shifting patients from one room to another, thus permitting the air of the room to be thoroughly changed.

Treatment of the Symptoms.—The instructions given above apply more particularly to the prevention of symptoms. The treatment of the symptoms themselves is equally difficult. Generally we give the patient a dose of aromatic spirits of ammonia immediately after the treatment, and this may be repeated every three or four hours as long as the symptoms last with the object of overcoming the sense of prostration which sometimes develops. In addition to this, if the symptoms are marked, the patient should be placed in bed or in a reclining chair in a well-ventilated room, or even out of doors. Generally the symptoms disappear within a few hours to a few days, and fortunately the symptoms do not develop in more than one-quarter of the patients.

Conclusions.—1. In a small proportion of the patients to whom are given large doses of roentgen rays, there develops constitutional symptoms consisting of nausea, occasional vomiting, and a certain amount of prostration.

2. These symptoms are probably due in great part to the gases generated in the neighborhood of the high tension currents, together with a hypersensibility on the part of the patient.

3. They can be prevented in great part by eliminating these gases and by means of thorough ventilation.

4. They can be relieved by rest, stimulants and aëration.

ROENTGEN OBSERVATIONS ON THE DUODENUM WITH SPECIAL REFERENCE TO LESIONS BEYOND THE FIRST PORTION

BY JAMES T. CASE, M.D., F.A.C.S., BATTLE CREEK, MICH.

THE earliest roentgen studies of the alimentary tract following the ingestion of an opaque meal were carried out with special reference to the esophagus and stomach. Five or six years passed before there were reported any systematic studies on the duodenum, yet in spite of its later development, the roentgen findings in duodenal ulcer are more reliable and more accurate, even in the early stages, than in the investigation of gastric ulceration.

Of late, especially, has particular attention been given to the duodenum, with a resulting marked increase in the range of possibilities of diagnosis. Aside from ulcer of the duodenum, which has been fully considered by another speaker in this symposium, the following are conditions affecting the duodenum, or at least associated with the duodenum in which the *x*-ray may afford diagnostic aid: duodenal obstruction; gall tract disease involving the duodenum, as by adhesions; certain stages of pancreatic disease; diverticula of the duodenum other than the diverticulum of Vater; dilatations and tumors relating to the ampulla of Vater. The writer has made no special effort to be exhaustive in the foregoing enumeration, but only to stimulate a discussion of some of the newer possibilities of duodenal roentgenology.

Before taking up the consideration of these various topics, it may be well to briefly review the anatomy of the duodenum and to decide upon terms for use in describing the various segments of this very interesting organ.

Anatomically, the normal duodenum is divided into four portions,—the first portion (pars superior, bulbus duodeni, the "cap"); the second portion (pars descendens); the third, horizontal portion (pars inferior); and the fourth, short portion (pars ascendens). The angle between the first and the second portions is called the genu superius; that between the second and third portions, the genu inferius.

In the adult the duodenum passes backward, upward and to the right between the quadrate lobe of the liver to the neck of the gall bladder; it then curves sharply, descending along the right margin of the head of the pancreas, generally to the level of the upper border of the body of the fourth lumbar vertebra; again curving sharply it passes transversely across the vertebral column, inclining slightly upward. In its fourth portion, it ascends for about two and one half centimeters, ending at the duodeno-jejunal junction, which with the patient supine is opposite the second lumbar vertebra.

The first portion of the duodenum, usually called the bulb, extends from the pylorus to the neck of the gall bladder. It is the most freely mobile of the four portions. To the upper border of the first half is attached the hepatico-duodenal ligament. The bulb is in such close relation to the gall bladder that it is often found bile-stained after death, the stain being especially noticeable on its anterior surface. This makes it easy to understand why the duodenum is so often involved in adhesions following pericholecystic inflammation. The bulb, which normally measures five centimeters in length, is usually triangular in shape, the base of the triangle forming the duodenal side of the pyloric sulcus. According to L. G. Cole, the duodenal bulb has the shape of a cap surmounting the pylorus, corresponding in size and shape with the pyloric end of the stomach. Its outline is smooth-edged, usually triangular or elliptical in shape. The mucous membrane is smooth unless there is actual disease present, there being in the shadow no trace of the

serrations due to the Kerkringian folds which characterize the remainder of the duodenum.

The pylorus is seen roentgenologically as a circular constriction separating the duodenal bulb from the pyloric end of the stomach. The sulcus thus formed is usually about a quarter of an inch in diameter, and is bisected by a narrow shadow (the pyloric canal) which connects the stomach with the bulb. Even when the pylorus is closed, this narrow channel, measuring about an eighth of an inch in diameter, is visible, owing to the adhesion of minute quantities of barium to its mucosa. This adhesion of opaque salt to the mucous lining of the pylorus has led some into the error of contending that the pylorus is always open. When the pylorus is really open, the canal is seen to be widely distended, measuring as much as half an inch in diameter. The pyloric lumen thus visualized should occupy a midpoint in the sulcus in the gastro-duodenal shadow produced by the pyloric sphincter.

The duodenal bulb may occupy a position symmetrically above the stomach so that were one to cover the pyloric sulcus the shadow of the bulb would be seen to correspond in size and shape to the pyloric end of the stomach. Sometimes the bulb is not thus symmetrically placed; it may be pushed to the left by pressure of the liver, or pulled to the right by adhesions, or it may be held in its normal position while the pyloric end of the stomach is displaced to the right or left.

The second portion of the duodenum is nine or ten centimeters in length, and with the patient in the horizontal position, extends along the vertebral column from the first to the third or fourth lumbar vertebra. Though this part of the duodenum is normally without a mesentery and is considered fixed, it is astonishing how readily it responds in most cases to the pressure of the manipulating finger. It is also subject to considerable change in shape and position during the movements of forced respiration. Occasionally one is able to make out the insertion of the ampulla of Vater into which empty the common bile duct and the pancreatic duct, about eight or nine centimeters from the pylorus. This portion of the duodenum invariably shows the serrations and feathery appearance due to the Kerkringian folds. Dwight found that the second portion of the duodenum may be very large, and yet not over-distended.

The duct of Wirsung and the common

FIG. 1. VISUALIZED SMALL INTESTINE, SHOWING DUODENUM, RIGHT UPPER; JEJUNUM, LEFT UPPER; AND ILEUM, LEFT LOWER.

Note the feathery appearance of the duodenum and jejunum, due to Kerkring's Valves. The shadow of the ileum shows conglomerate denser barium masses.

bile duct usually unite in a common channel to form a small oval or triangular cavity, known as the ampulla or diverticulum of Vater. This cavity lies in the wall of the duodenum, measuring, on an average, four millimeters in length. According to Opie, it may measure as long as eleven millimeters, while in other cases it may not exist at all, the two ducts opening side by side in the common papilla. The average diameter of the duodenal opening of the am-

pulla is, according to Opie, 2.5 millimeters. Sometimes this diameter may even exceed the length of the diverticulum.

The third and fourth portions of the duodenum together measure from seven to ten centimeters in length. Like the second portion, these segments of the duodenum are practically fixed, being bound down to neighboring viscera and to the posterior abdominal wall by peritoneum, yet at times one is able to demonstrate an astonishing degree of mobility of the duodenal shadow. The fourth part and the duodeno-jejunal flexure are fixed by the suspensory muscle of the duodenum, called the ligament of Treitz.

Technic.—The patient, standing erect before the fluorescent screen, swallows a third of a glass of water into which has been stirred a heaping teaspoonful of barium sulphate. One watches particularly the pyloric region for the behavior of the first of the opaque mixture to reach it. This barium-water mixture usually begins to pass at once into the duodenum, so that one is able to show that the duodenum is more or less well visualized from the very beginning of the meal. This is followed by the usual barium meal, which, in the writer's practice, consists of one ounce of barium sulphate in a glass of hot malted nuts or hot malted milk, and one ounce in a glass of buttermilk, given cold. A brief further observation is made with the patient erect. He is then placed upon the horizontal table, and if any delays are incurred, he is asked to spend the interim lying on the right side. When all is made ready so that the observation can begin the instant the patient turns on the back, he is asked to inhale, hold the breath and turn quickly upon the back. The observer with one hand makes pressure over the duodeno-jejunal junction, at the same time pressing pylorusward the contents of the stomach. Special care is taken to compress the duodenum between the palpating hand and the spine, thus artificially obstructing the duodenum, and incarcerating its contents. The use of a wooden spoon device is an addition to the safety of this maneuver. This method of blocking off the duodenum, which the writer has practised for the last five or six years, can be accomplished more satisfactorily in the horizontal than in the upright position, although the technic for the upright position worked out by Holzknecht and Lippmann has a certain value. By pressure over the duodeno-jejunal junction, which is thus shut off between the spine and the compressing finger, the duodenum is easily filled from pylorus to duodeno-jejunal junction and its entire contour easily made out. The alternating waves of onward and retrograde peristalsis resulting from this temporary obstruction still further test the elasticity of the duodenal walls so that one is no longer in doubt as to the presence or absence of deformities.

At irregular intervals, depending upon the mechanism which controls the opening of the pylorus, the duodenal bulb contracts, the contraction appearing about two centimeters beyond the pylorus. This contraction is occasionally seen to begin at the pylorus itself. This contraction in the bulb occurs when an antrum contraction is nearing the pylorus, usually when the antrum contraction wave is about an inch from the pylorus. Serial roentgenograms, according to the method of Kaestle, further developed by Pirie, will demonstrate beautifully the nature of this duodenal bulb contraction. This is a ring contraction wave which carries a bolus of material usually the entire length of the duodenum past the duodeno-jejunal junction. Were one to depend solely upon roentgenography for his roentgen findings, the appearance of barium traversing the duodenum in connection with one of these ring contraction waves might lead to an erroneous diagnosis of duodenal obstruction. One frequently sees reverse peristalsis in the duodenum. This is independent of respiration as can be seen by studies during suspended respiration. Although in obstruction of the duodenum one may observe reverse duodenal peristalsis,

these waves are not necessarily pathognomonic of an organic obstruction. They may also be seen when an emaciated patient is lying upon the back and the duodenum is compressed by saddling across the spine.

A study of the duodenum with the patient in the right lateral position is also useful. The patient lies on the right side, with the screen held directly in front of him. The rays penetrate from behind. This position is especially useful in studying the pyloric region, but also lends itself to a study of the duodenum.

Duodenal Obstruction.—Reference must be made to the theory of Lane's duodeno-jejunal kink, and its relation to the causation of duodenal ulcer. For present purposes it may suffice for the writer to state his unbelief that the so-called kink which one can demonstrate in a great many patients at the duodeno-jejunal junction, has any definite or constant relation to duodenal obstruction. That such an obstruction occasionally occurs is, of course, understood, but the writer can not believe that it is a common finding. Various others have advanced theories regarding the causation of duodenal stasis, as, for instance, by drag of the mesentery across the third portion of the duodenum (so-called mesenteric ileus).

The writer would only call attention to the fact that the so-called "writhing duodenum," believed by Jordan to be pathognomonic of duodenal obstruction, is demonstrable in almost every thin patient when examined in the supine position and with the large opaque meals given by Jordan. It should further be remembered that the appearance of normal peristalsis in the duodenum may simulate obstruction, especially if one depends upon roentgenography alone. A true duodenal obstruction should be demonstrable on repeated examination and should seriously interfere with the passage of material past the seat of hindrance. Many cases of so-called "writhing duodenum," supposed to be due to obstruction at the duodeno-jejunal junction, exhibit also early filling of the upper small bowel and such extensive and complete distribution of bismuth throughout the entire small intestine, with clearance of both the stomach and duodenum within the normal time, that one can not entertain the idea of obstruction. Cases of true duodenal obstruction (below the pars superior) have been encountered only rarely in the writer's experiences,—not over twenty or twenty-five instances. These cases have, for the most part, been associated with ulcer or carcinoma on the posterior wall of the stomach with adhesions involving the duodenum or the jejunum in the neighborhood of the duodeno-jejunal junction.

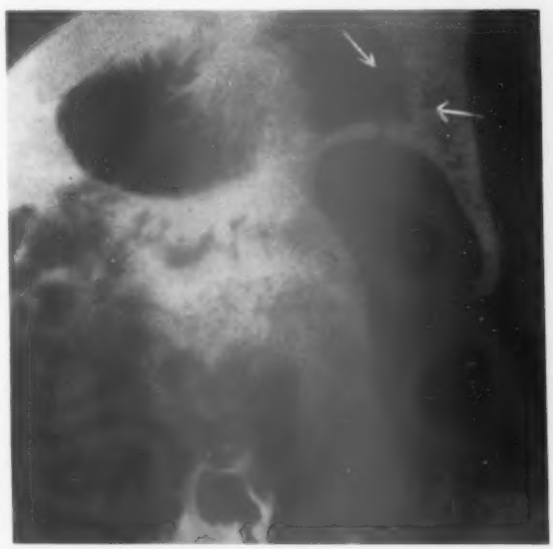


FIG. 2. MARKED DISTENTION OF THE DUODENUM, PATIENT LYING SUPINE.

The duodenum is widely filled, owing to saddling of the gastro-duodenal shadow over the spine. A duodenal ulcer is shown at arrows but there was no duodenal obstruction and no duodenal or gastric stasis. With the patient lying upon the face or standing there was no duodenal distention.

One must exercise great care and judgment to distinguish duodenal stasis and duodenal dilatation from wide filling of the third portion of the duodenum, especially if the patient is examined in the supine position upon the horizontal fluoroscope, for in this position, especially when the patient is poorly nourished, the duodenum saddles over the spine in such a way as to make a certain degree of obstruction at the duo-

deno-jejunal junction. This causes the appearance of alternating onward and retrograde peristalsis in the duodenum similar to that described by Jordan as "writhing duodenum" which he considers pathognomonic of ileac stasis. These cases of pseudo-duodenal obstruction or even functional duodenal obstruction may be differentiated from the organic obstruction by the fact that they are seen only with the patient in the supine position, whereas the organic obstructions are evident in all positions. This unusual visualization of the duodenum

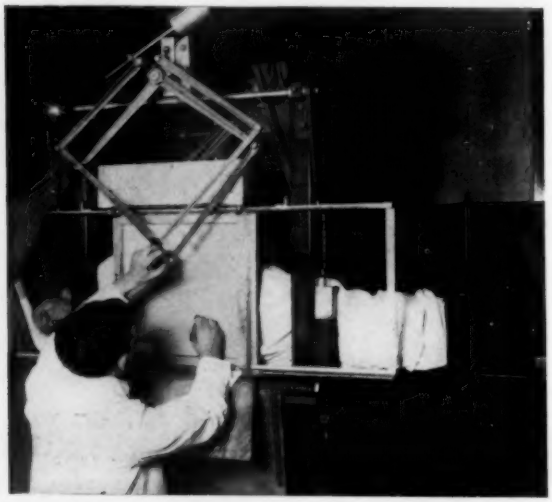


FIG. 3. AN ILLUSTRATION OF THE RIGHT LATERAL POSITION, SCREEN HELD VERTICALLY IN FRONT OF PATIENT.

This position is especially valuable in studying the duodenum and pyloric end of the stomach. (See Figure 12.)

may be due, not to a spastic hindrance, but to too rapid delivery of gastric contents into the duodenum through pyloric insufficiency. This insufficiency may be associated with achylia or duodenal ulcer, or it may be due to adhesions or induration about the pylorus. When the duodenum is unusually filled under these circumstances, one rules out obstruction at the duodeno-jejunal junction if there is free filling of the first part of the jejunum. If the patient has been resting upon the right side for a few moments preceding the fluoroscopic observation or preceding the roentgenographic record, one is likely to find the duodenum unusually filled.

Duodenal obstruction may occur in connection with a rare anomaly of the head of the pancreas. Normally the head of the pancreas may involve a portion of the wall of the second part of the duodenum, but in certain rare cases the overlying is so great that the whole circumference of the bowel is enclosed by pancreatic tissue. This anomaly may result in obstruction, either congenital, or later in life as the result of inflammatory changes or tumor invasion. In one instance reported by Symington, the circumference of the distended duodenum where it was surrounded by the pancreas was two and a half inches, while above and below this point it was more than three times as large.

The writer considers that very seldom indeed do adhesions between the gall bladder and the duodenum result in duodenal obstruction. On the contrary, it seems that in most cases the emptying time of the stomach is unusually short. These adhesions are not always confined to the first portion of the duodenum; they sometimes involve the duodenum extensively, producing a characteristic deformity which can be recognized by careful palpation under fluorescent screen guidance. When, as occurs in many fortunate cases, the gall stones contain a sufficient portion of opaque salts, there is added accuracy to the roentgen findings.

Carcinoma of the Duodenum.—The writer has recognized only one case of carcinoma of the duodenum. This was a malignant tumor located about the papilla of Vater, which was easily recognized by the special method of duodenal examinations described above. In a case personally reported to the writer by Lippmann, the findings were exactly identical, the tumor being located in the papilla of Vater, and being discovered with a similar technic.

Ulcer.—Ulcer of the duodenum beyond the first portion is of relatively rare occurrence, but with the technic described, it

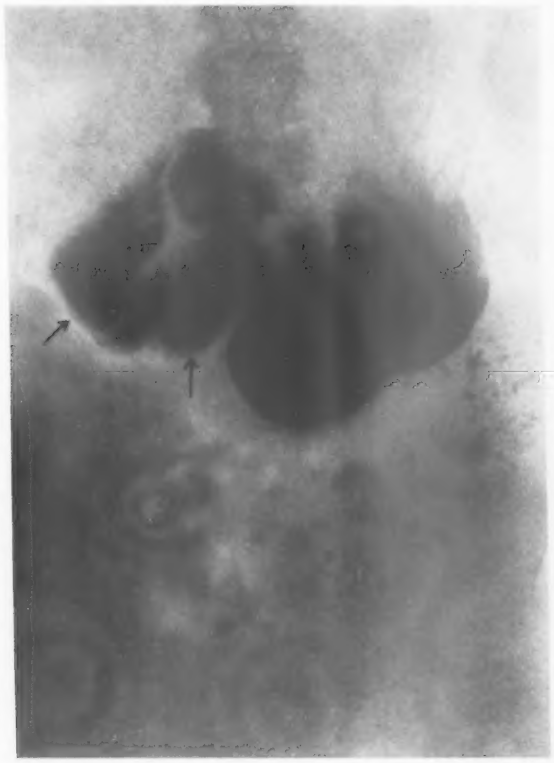


FIG. 4. DUODENAL OBSTRUCTION, DUE TO ADHESIONS ATTENDING ULCER ON THE POSTERIOR WALL OF THE STOMACH NEAR THE PYLORUS; PATIENT ERECT.

FIG. 5. SAME CASE AS SHOWN IN FIG. 4. BUT SIX HOURS LATER; PATIENT ERECT.

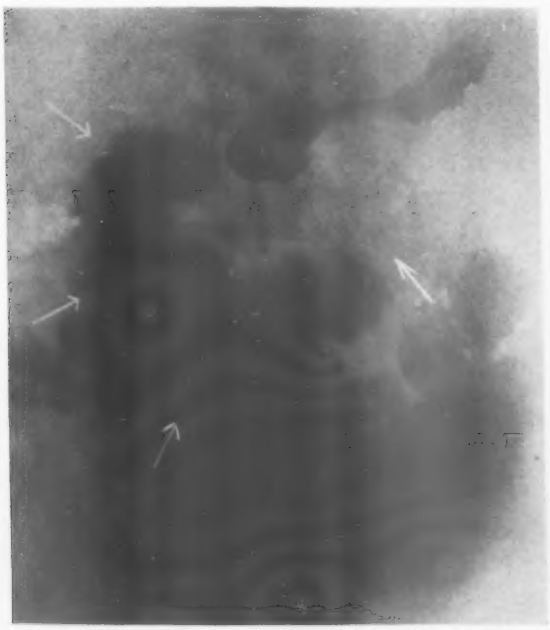


FIG. 6. EXTENSIVE CARCINOMA OF THE STOMACH, WITH PERIGASTRIC INVOLVEMENT NEAR THE DUODENO-JEJUNAL JUNCTION, WITH PRONOUNCED DUODENAL OBSTRUCTION AND DILATATION.

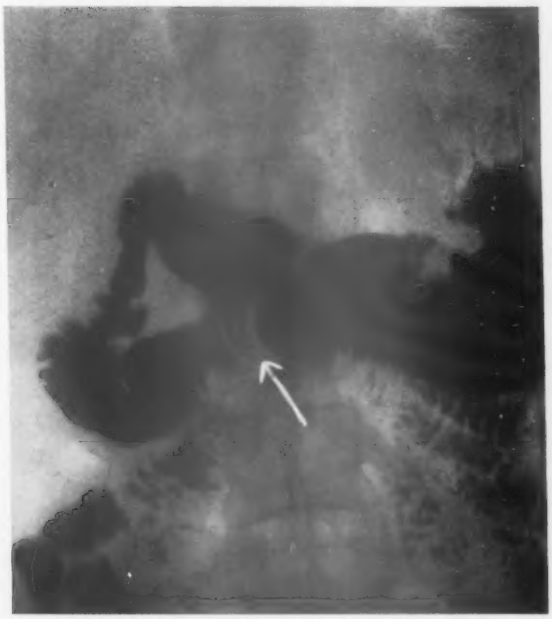


FIG. 7. DUODENAL OBSTRUCTION, DUE TO ADHESIONS NEAR THE DUODENO-JEJUNAL JUNCTION.

No ulcer demonstrable. Ten hours required for emptying duodenum. Relieved by dividing adhesions.

FIG. 8. PHYSIOLOGICAL APPEARANCE OF THE ACTIVE DUODENUM WHICH MIGHT SIMULATE DUODENAL OBSTRUCTION.

A bolus of food is being passed along the duodenum by peristalsis.

should be demonstrable. No cases have been recognized in the writer's work.

Differential Diagnosis Between Cholecystic and Pancreatic Tumor.—A. W. Crane long ago called attention to the fact that an enlargement of the head of the pancreas might be inferred from studies of the duodenum. By employing a modification of Crane's technic, the writer has, during the last few years, been able, in a few cases, to make a diagnosis of tumor of the head of the pancreas. Sometimes the distortion of the duodenal loop may be utilized in differentiating between a tumor of the head of the pancreas and a tumor of hepatic or cholecystic origin, as will be illustrated by the following case:

Male, adult, Syrian, with a tumor in the right upper quadrant, was referred by Dr. A. E. Halstead for differential diagnosis. Underneath the right costal margin could be felt a rounded, partially compressible tumor, larger than one's fist. During inspiration the tumor seemed to move up and down. By compression its size could be diminished by one-third. Study was made in view of the possibility of parasitic disease, but nothing was found. By exclusion, the diagnostic possibilities were finally reduced to a distended gall bladder or a pancreatic cyst.

After the patient had taken a few swallows of barium, it required only a brief glance at the fluorescent screen to decide that the tumor was pancreatic instead of cholecystic. The duodenum was pushed upward and outward to the right in such a manner as to indicate clearly a tumor of the head of the pancreas. At operation, Dr. Halstead evacuated a large pancreatic cyst (Figs. 10 and 11).

In a similar case of query between cholecystic and pancreatic tumor, the diagnosis was clearly made in favor of the former, because the duodenum was displaced downward away from the liver, in such a way as to suggest a large gall blad-

FIG. 9. A CASE OF CHOLELITHIASIS WITH PERICHOLECYSTIC ADHESIONS INVOLVING THE DUODENUM.

Gallstones shown at arrows adjacent to the visualized adherent duodenum.

der. At operation by Dr. L. L. McArthur, there was found abundant evidence of malignant disease with enormous distension of the gall bladder and secondary involvement of the liver.

The writer has observed that whenever for any reason the pancreas is involved, there is quick clearance of the stomach after a barium meal, and unusual visualization of the duodenum. An exception must be made, of course, where there is a cicatricial or

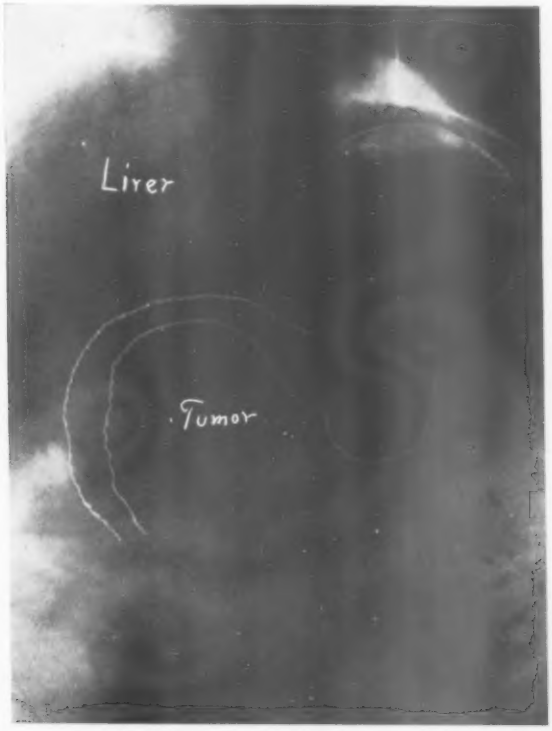


FIG. 10. TRACED ROENTGENOGRAM ILLUSTRATING DISPLACEMENT OF THE DUODENUM UPWARD AND TOWARD THE RIGHT IN A CASE OF TUMOR OF THE HEAD OF THE PANCREAS—IN THIS INSTANCE A LARGE PANCREATIC CYST.

Operated upon by Dr. A. E. Halstead (See Fig. 11)

mechanical obstruction at the pylorus or in the duodenum. For instance, in cases of penetrating ulcers on the lesser curvature which involve the pancreas, the stomach empties quickly. In pancreatic carcinoma with adhesions to the duodenum, the stomach empties quickly, perhaps here on account of achylia. In several cases of duodenal or jejunal diverticula with penetration into the pancreas, gastric motility has been characterized by early clearance.

Duodenal Diverticula.—Real diverticula of the duodenum are of rare occurrence. One occasionally finds a sort of diverticulum associated with the scar of duodenal ulcer, or with pericholecystic adhesions, but these occur in the first portion of the duodenum. The ampulla of Vater is a sort of duodenal diverticulum, as its name would indicate. The writer has observed eight cases of real diverticulum of the duodenum, occurring in the pars inferior. The following are the details of one case:

FIG. 11. ROENTGENOGRAM OF THE SAME CASE SHOWN IN FIG. 10, TWO HOURS AFTER THE MEAL.

The thin shadow of the dislocated duodenum is shown at the arrows.

The patient, female, age 45, applied for treatment for a pain of six years' standing, located in the lower dorsal region. The pain was constant, and of late more intense, increased by lying down, and by making pressure over the abdomen or over the spine. Vomiting was a frequent symptom.

Roentgen examination revealed an unusually large barium fleck (the size of a

FIG. 12. ROENTGENOGRAM MADE IN THE RIGHT LATERAL POSITION, PATIENT LYING UPON THE RIGHT SIDE, PLATE HELD VERTICALLY IN FRONT OF PATIENT, TUBE POSTERIORLY (See Fig. 3).

The duodenum is shown as a thin shadow, owing to compression by carcinoma involving the pancreas, gall bladder and pyloric end of the stomach.

filbert) in the ampulla of Vater, persisting for about nine hours, and a definite diverticulum of the duodenum in the pars inferior. This diverticulum was ovoid, measuring 2.5 x 5.0 cm. It retained food a little longer than the time required for emptying the stomach (six hours). There was very definite tenderness on accurate pressure over the head of the diverticulum which occurred upon the mesial side of the duodenum, and seemed to have a relation to the head of the pancreas. The other *x*-ray findings in the bowel were inconsequential. The *x*-ray findings, together with other clinical data in the case, led to the diagnosis of chronic pancreatitis, possible gall stones and a diverticulum of the duodenum (see Fig. 13).

At operation by Dr. J. H. Kellogg, the gall bladder was drained, the appendix removed, the incompetent ileocecal valve repaired, and the stomach and duodenum carefully examined. The diverticulum was found 5 cm. above the duodeno-jejunal junction, in the third part of the duodenum. The diverticulum extended upward behind and into the substance of the head of the pancreas and lay in close approximation to the superior mesenteric vessels. The connection of the diverticulum with the pancreas was so intimate, and the surroundings so vascular, that it was not thought wise to remove it, especially since the patient's symptoms seemed to be due to a chronic pancreatitis and not to the diverticulum itself. The head of the pancreas was somewhat enlarged. At the last report, six months after the operation, the patient had remained free from the severe pain which first suggested pancreatic disease.

The first duodenal diverticulum was reported by Morgagni in 1761. Occasional references to this condition are encountered in the literature, especially by Roth, Schueppel, Pilcher, Hansemann, Hodenpyl, Keith, Jackson and Baldwin. Baldwin in 1911 collected in the literature and reported from his own observations eighty-two cases of duodenal diverticula. In many instances, the diverticula seemed to involve or take the place of the diverticulum of Vater, but in about half the cases the diverticula were entirely independent of the bile and pancreatic ducts and in eighteen cases they occurred in the pars inferior. In twenty-one of the eighty-two cases, the diverticula penetrated into the head of the pancreas. In many instances, from the description it is difficult to determine that the diverticula were not enlargements of the normal ampulla of Vater. Indeed, Keith reports a case of ptosis of the duodenum in which he considered that traction upon the common bile duct had produced a large diverticulum of the duodenum at the major papilla. It is noteworthy that in only a few of the cases of duodenal diverticula were there any clinical signs of an inflammatory process.

Dilatation of the Ampulla of Vater.—

FIG. 13. A LARGE DIVERTICULUM OF THE THIRD PORTION OF THE DUODENUM.

(a) Pylorus, (b) Diverticulum, (c) Visualized ampulla of Vater. Operated case.

FIG. 15. SAME ROENTGENOGRAM SHOWN IN FIG. 14, BUT WITHOUT TRACING.

Operated case.

FIG. 14. LARGE DIVERTICULUM OF THE THIRD PORTION OF THE DUODENUM.

Traced roentgenogram from same plate shown in Fig. 15.

FIG. 16. ENORMOUS DIVERTICULUM OF THE THIRD PORTION OF THE DUODENUM SHOWN AT ARROWS.

Operated case.

FIG. 17. DILATED AMPULLA OF VATER WITH STASIS LONGER THAN FOUR DAYS IN A CASE OF MULTIPLE DIVERTICULA OF THE COLON.

In this roentgenogram the colon is shown filled by the barium enema.

In considering the etiology of pancreatitis, it will be recalled, as Opie first suggested, that a small gall stone may lodge in a large diverticulum of Vater, obstructing the opening of the diverticulum into the duodenum and converting the diverticulum into a through channel from the common bile duct into the pancreatic ducts. The forcing of infected bile directly into the pancreatic duct under such circumstances is doubtless a common cause of acute pancreatitis. That this obstruction may result from other causes than the impaction of gall stones is probable.

Oddi has shown that there exists about the ampulla a sphincter formed by a thin layer of involuntary muscle. Is it not possible that spasm of this sphincter may occur under certain circumstances?

Williams and Bush (*Journal of Medical Research*, Vol. XVII, No. 1, October, 1907) suggest another mechanism, viz., that the passage of gall stones may so dilate the opening of the diverticulum of Vater that intestinal contents may pass into the pancreatic duct, resulting in an inflammatory reaction. They cite numerous anatomical and experimental evidences that make it seem probable that some cases of acute pancreatitis have been caused in this way.

Edward Archibald, of Montreal, is a strong believer in spasm of the sphincter at the duodenal end of the ampulla of Vater as a cause of pancreatic disease. He believes that the irritation which results in this sphincteric spasm may be supplied by duodenal ulcer, which is not at all infrequent in cases of pancreatitis. That spasm should alternate with undue relaxation seems quite natural. The writer has seen perhaps fifteen cases where a very appreciable amount of opaque salt entered the ampulla of Vater. In the majority of instances, these cases have exhibited clinical signs of chronic pancreatitis. Is it not probable that there is a definite relation between dilatation of the ampulla of Vater and chronic pancreatic disease? If the dilatation of the ampulla be the result of chronic spasm of the common duct sphincter, then it is necessary to suppose, as Dr. Archibald suggests, a periodical undue relaxation of the sphincter in order to explain the entry of the opaque salt.

The formation of the ampulla of Vater and the termination of the common bile duct and the pancreatic duct may occur in at least six variations, as related by Robson and Cammidge. The *first* is the classical type in which the last segment of the common bile duct, comprising all that portion of the canal contained in the thickness of the wall of the duodenum, passes obliquely through the muscular coat of the intestine and then dilates into a little reservoir underneath the mucous membrane, into which the main pancreatic duct also opens, known as the ampulla of Vater. In the *second* type, the pancreatic duct joins the common bile duct some little distance from the duodenum, but the ampulla of Vater is absent, the duct opening into the duodenum

by a small, flat, oval orifice. In the *third* type, the two ducts open into a small fossa in the walls of the duodenum while the papilla of Vater and the ampulla of Vater are absent. In the *fourth* type, the papilla is well developed, but the ampulla is absent, the two ducts opening side by side at the apex of the papilla. In the *fifth* type, the common bile duct opens along with the duct of Santorini and the duct of Wirsung enters the duodenum separately. In the *last* type, the pancreas has three separate ducts opening into the duodenum, one only accompanying the common bile duct.

When the pancreatic and the common duct terminate in the first (the classical) type or in the second variety of termination, as above noted, the onset of pancreatitis in the case of common duct cholelithiasis or spastic contraction of the common duct sphincter will be favored. The duct of Santorini is present in less than half of all the cases, hence this duct can not be counted upon to act as a safety valve to the duct of Wirsung when it is compressed.

In one of the writer's cases, the diverticulum of Vater appeared to be double. That this occasionally occurs is noted in the anatomies. This patient had not only multiple diverticula of the colon, but also multiple diverticula of the small bowel, two large ones, the size of pigeons' eggs, beyond the duodeno-jejunal junction. In still another case of dilated ampulla of Vater, there were numerous diverticula of the jejunum, but none were found in the colon.

In any case, it is of extreme interest to note that in the majority of instances of dilated ampulla of Vater, as shown by the entry of barium at the time of the barium meal, there have been clinical signs of chronic pancreatitis.

It is of further interest that in many cases showing dilated ampulla of Vater, there have also been demonstrated multiple diverticula of the colon, and in two cases multiple diverticula of the jejunum. In some of these cases the symptoms of colonic

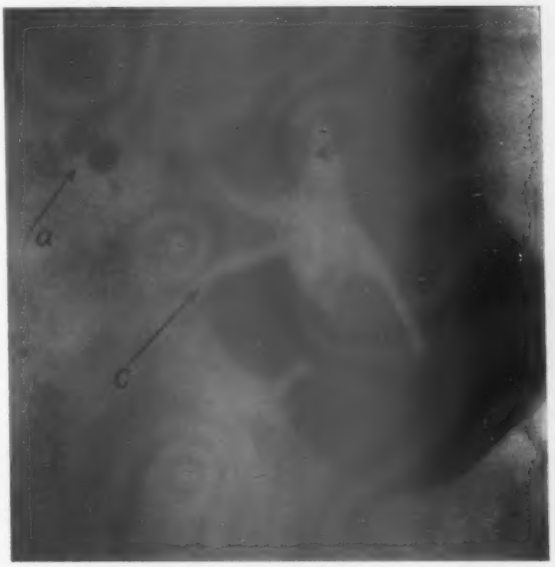


FIG. 18. DOUBLE AMPULLA OF VATER.

(a) Double ampulla of Vater. (b) Large diverticulum of the duodenum near duodeno-jejunal junction. (c) Pylorus. Operated case.

diverticulosis were over-shadowed by epigastric symptoms strongly suggestive of a pancreatic lesion. Although the cases are as yet too few to warrant any deductions, it is of great interest to recall that out of fifteen or sixteen cases of unusual patency of the papilla of Vater, with filling and stasis of the opaque salt in the diverticulum of Vater, about half the patients were clinically suffering from chronic pancreatitis, whereas the other half had multiple diverticula of the colon, and some of them had symptoms of both lesions.

A close watch of similar cases with reports of findings by many observers will, let us hope, soon permit definite conclusions as to the worth of this observation.

The question has also arisen as to the possibility of barium entering the common duct and passing into the gall bladder. It is not only possible, but quite the rule, for barium to fill the gall bladder after the operation of cholecystenterostomy. The writer has demonstrated this in the two cases where he has had the opportunity to make a post-operative examination in such cases. The barium was retained longer than

FIG. 19. GALL BLADDER VISUALIZED BY ENTRY OF BARIUM.

(a) Large diverticulum of the duodenum, third portion. (b) Gall bladder containing stones, visualized by entry of the barium following barium meal.

FIG. 20. GALL BLADDER (AT ARROWS), FILLED THROUGH CHOLECYSTENTEROSTOMY OPENING.

forty-eight hours in one instance, and in the other longer than four days. In one instance, the records of which will be shown on the screen, it is probable that barium entered the gall bladder and visualized gall stones which had previously been invisible roentgenologically. The patient did not consent to operation.

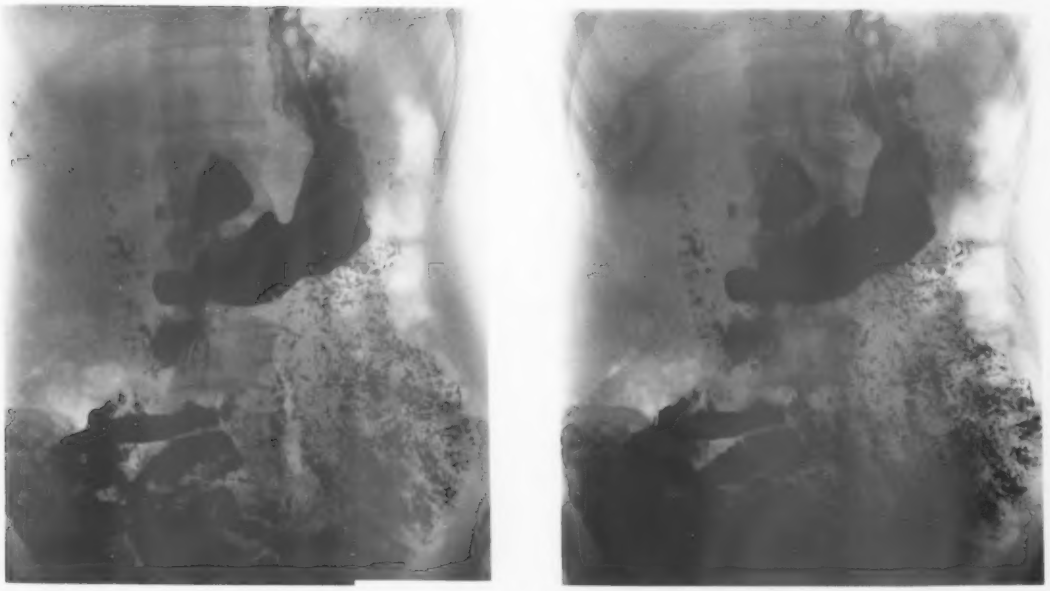
Some of the points in the foregoing pages are new as far as the roentgenological aspects are concerned. They are presented here not because they are settled facts, but in an effort to broaden the field of diagnostic possibilities with reference to the duodenum. The differential diagnosis of right upper quadrant lesions will ever be a most interesting and intricate subject, and if roentgenologists can bring to the internist any additional information by means of our special methods of study, we will be making a valuable contribution to the diagnostics of internal medicine.

STEREOROENTGENOGRAM TO ACCOMPANY THE ARTICLE

BY DR. J. T. CASE, ON

ROENTGEN OBSERVATIONS ON THE DUODENUM

This roentgenogram of the abdomen, patient prone, plate anteriorly, two hours after the ingestion of the barium meal, shows the well-filled stomach, scattered traces of barium in the duodenum, a small amount of barium in the ampulla of Vater, and a well defined *diverticulum of the duodenum*. The shadow of this diverticulum is partially hidden by the pyloric end of the stomach. The barium in the upper portion of the small bowel is shown in fine feathery shadows, whereas the ileum shows more conglomerate solid shadows of barium. This diagnosis was confirmed at operation by Dr. J. H. Kellogg.



REPORT OF A CASE OF OSTEOSARCOMA OF THE HEAD OF THE FEMUR

JOSHUA C. HUBBARD, M.D., AND ARIAL W. GEORGE, M.D., BOSTON, MASS.

THIS case is reported simply to place on record a series of roentgen plates made over a period of three years, following an operation upon a bone cyst in the region of the neck and of the trochanter of the left femur. These roentgen plates illustrate apparently a process of repair in the area of the cyst or growth.

A roentgen diagnosis was made of benign bone cyst with spontaneous fracture.

Two problems arose after the roentgen diagnosis was made, namely, whether this case should be treated simply as a fracture, or whether it should become a surgical problem with particular attention given to the cyst or growth, irrespective of the fracture. The latter course was decided upon, and the question now arises whether the healing would have been more complete simply from the trauma of the fracture on the cyst or growth, or whether the growth per se would have progressed, and ultimately led to disaster.

The history as obtained from Dr. Joshua C. Hubbard is as follows:

Mr. McD., young adult. Seen in consultation with Dr. T. J. O'Brien, September 22, 1913. Fell about three hours before on a slippery floor. Trying to save himself, his left hip was injured while in the air. For two years occasionally he has been lame on the left leg, and the left leg is said to have been somewhat smaller than the other.

The deformity had much the appearance of a dislocation. Under ether, however, there was a definite crepitus. Prominence persisted, and the leg could be rotated internally and externally to the normal limit, and extended to a straight line. It was slightly short, compared with the right. The roentgen examination was made by Dr. A. W. George.

On September 26, under ether an incision was made over the trochanter and carried down to the bone. Under the fascia there was considerable old blood clot. Bone found broken so that the finger entered immediately into a cyst as large as a lemon. Filled with soft tissue. Soft tissue scraped out. An immediate pathological report showed a giant cell sarcoma. The opening into the cyst was enlarged, and carefully wiped out with crude carbolic and alcohol. Packing left inside the cyst and the fascia and skin closed, leaving room for the packing. Plaster of Paris spica bandage from the ankle to the ribs applied.

PATHOLOGICAL REPORT

Dr. F. B. Mallory reports as follows:

Gross specimen consists of bits from the inside of the wall of the cyst. Also particles from the edge of the opening into the cyst containing bone..

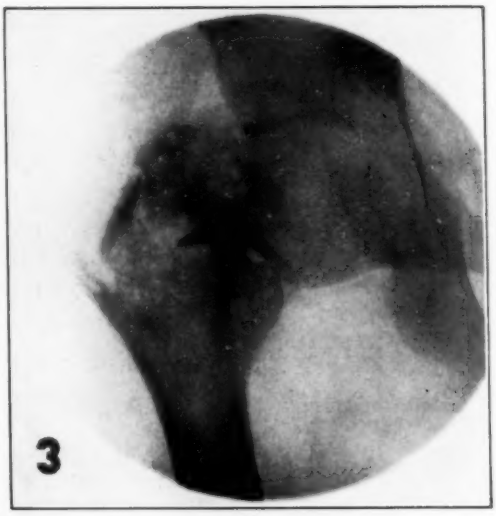
Microscopical examination of sections and different pieces of the tissue removed shows in places a rapidly growing tumor, composed of cells varying from spherical to spindle-shaped and giving rise here and there to masses of a homogeneous intercellular (osteoid) material. Mitotic figures are present in moderate numbers, indicating fairly rapid growth. In other places there are fragments of old bone and areas of granulation tissue, indicating an attempt at repair.

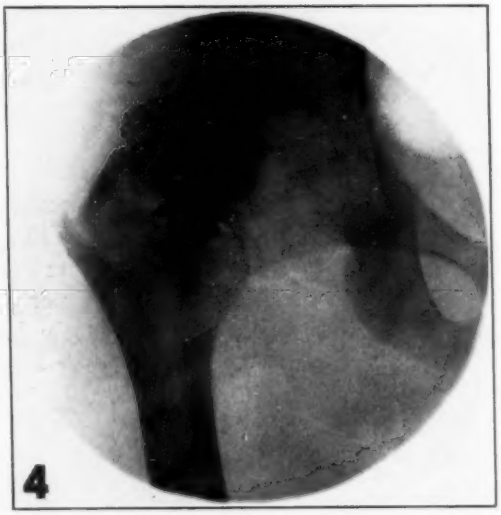
Pathological Diagnosis: Osteosarcoma

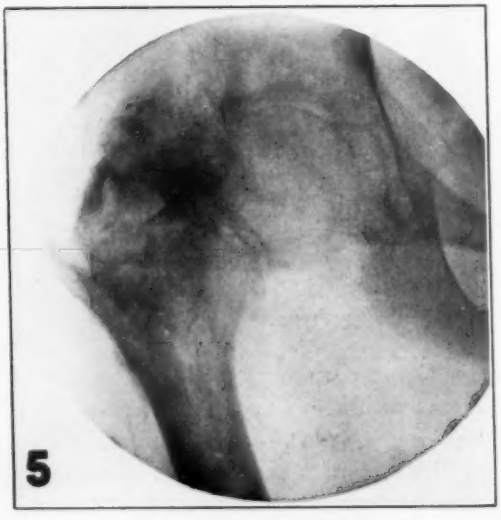
The patient had an uneventful convalescence, except for a few days there was a rise of temperature and pulse with a cough. The roentgen examination of the chest taken at this time was negative. The temperature and pulse gradually became normal and there was no definite explanation for their cause.

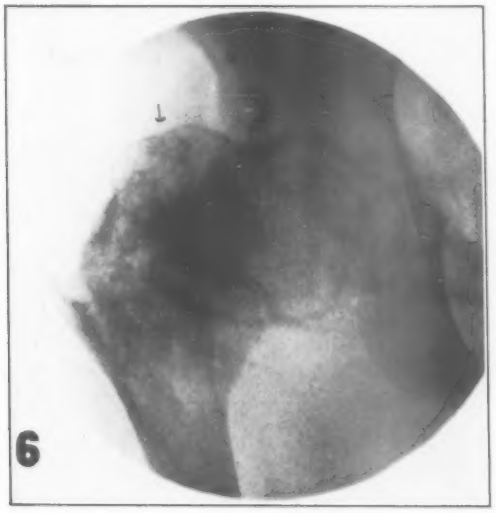
December 11, 1913, he was up and about on crutches. From that date he was followed carefully, numerous roentgen plates being taken by Dr. A. W. George.

Up to December, 1915, the case had progressed smoothly without any evidence of recurrence or extension. He was seen in the Fall of 1915 when he was walking without either cane or crutch with a slight limp. His thigh can be flexed to about eighty degrees.









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(For description of plates see following page.)

Plate I, September, 1913, shows a fracture of the neck into the trochanteric region about which is a cyst which includes this area and part of the shaft. The cyst is characterized by absorption and lack of bone salts. Here and there throughout the area are seen coarse trabeculæ. The wall of the cyst is broken in one or more places. Of course it is impossible to state whether this latter condition existed previous to the fracture and injury or not.

Plate II, October, 1913, two weeks following the injury and operation, shows immediate and rapid filling in with new bone.

Plate III, November, 1913, shows a general atrophic change of the bones, particularly of the head of the femur. The change in the area of the cyst, except for a slight decrease in density, is about the same as shown in Plate II.

Plate IV, January, 1914, shows still atrophy of the bones, but more beginning evidence of strong bone arrangement throughout the cyst. Particularly noticeable along the superior border of the cyst is beginning cortex. Compare with Plates II and III.

Plate V, March, 1914, shows the condition about the same as in Plate I.

Plate VI, October, 1914, one year following the operation, shows the healing process particularly well defined about the area of fracture. The trabeculæ are more distinct and formed generally throughout the cyst. Note cortex about the superior border of the cyst.

Plate VII (screen plate), December, 1915, one year and two months following Plate VI, shows no particular change. Owing to the fact that there is no change between Plates VI and VII, a difference in period of one year approximately, the process of repair is apparently complete. As far as the roentgen evidence is concerned there is no evidence of reforming cyst.

Plate VIII (screen plate), made with patient standing, shows approximately the same condition as Plate VI.

TWO CASES OF URETERAL CALCULUS PRESENTING UNUSUAL SYMPTOMS UNDIAGNOSED FOR A LONG TIME

BY GEORGE E. PFAHLER, M.D., PHILADELPHIA

CASE No. 1.—Miss A. M., age 26. Was referred by Dr. Rachel Williams, February 3, 1910. She has suffered from paroxysmal pains in the left labium majus since seven years of age, or in all nineteen years. At first these pains only occurred about once a month; later, every few days. A sharp pain at times only lasted for a few minutes, but a dull pain often lasted for days. Sometimes these pains would awaken her at night. There was never any tenderness over the labia. Occasionally had pain in the left ovarian region. Pressure over the vulva at times relieved the pain. Urinalysis was reported negative. The condition was thought to be a neurosis, and was referred to me for some electrical treatment.

Bearing in mind the analogy of pain in the testicle in connection with ureteral calculus occurring in the male, I felt it important to first make a roentgen study before beginning treatment. This revealed a calculus in the left ureter about two inches above the bladder, which was removed by Dr. Gibbon extraperitoneally, with immediate and total relief of all symptoms.

CASE No. 2.—Mr. D. S., age 65, referred for examination by Dr. Herbert J. Smith. He had been suffering for eight years with spasmodic pains beginning in the rectum and radiating up through the left inguinal region to the crest of the ilium. At first the pains came on about every three months. Later they became almost con-

FIG. 1. CALCULUS IN LEFT URETER. CASE 1.

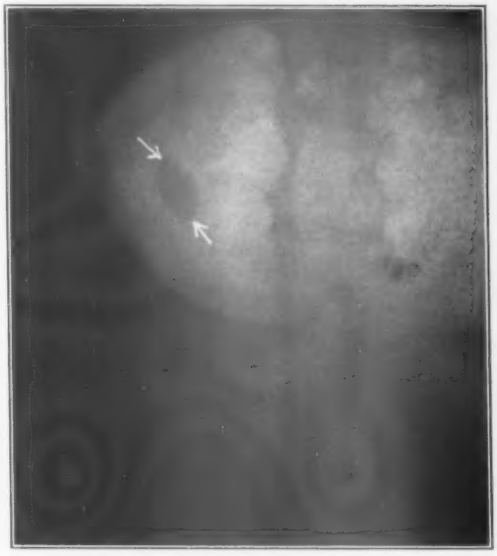


FIG. 2. CALCULUS IN LEFT URETER. CASE 2.

tinuous. When the pains radiated upwards he only got relief from hypodermics of morphine. Rectal examination was negative. Pains were worse when the rectum was full. There was no loss of weight. The bowels were regular. Urinalysis was negative.

Roentgen study showed a stone in the lower end of the left ureter. I always make a complete kidney, ureter and bladder examination whenever any part of the urinary tract is to be studied, and in this case incidentally found the evidence of six gall stones in the gall bladder.

A CONVENIENT METHOD OF MARKING AND MOUNTING DENTAL FILMS

BY ARTHUR R. METZ, M.D., CHICAGO, ILL.

OWING to the frequent request for *x*-ray examination of all the teeth, in search for foci of infection, the roentgenologist is called upon more frequently at present to make complete sets of films, which in turn necessitates explaining his findings to the general practitioner and dentist. In order to do this effectually and to avoid confusion later, when they are put into their hands for future reference, we are forced to mark and mount the films in a manner in which they may be easily identified.

The most satisfactory and simple method I have used for the past six months to mark the films, is to lay the exposed, unwrapped film packages in two rows, upper and lower in the order as taken, always starting from the right upper jaw posterior, and right lower jaw posterior. On the first film are the right upper molars; number two, the premolars and canine; number three, the four upper incisors; number four, the left upper canine and premolars; number five, the left upper molars. In a similar way the lower set is put on a corresponding number of films. The films are then marked, before developing, in the open room, by taking a needle and putting one perforation on the

incisor margin through the wrapper and the films, two perforations for film number two, three perforations for film number three, etc., to five perforations for the left upper

SHOWING METHOD OF MOUNTING FILMS ON CARD.

posterior. The lower set of films is perforated in a similar manner, from one to five beginning with the right lower posterior, with the addition of one extra perforation below the others to designate the lower jaw. They can then be unwrapped in the dark room and put in a small wire tray or basket and developed by floating free in the solutions, and can be easily transferred from one solution to the other by transferring the wire tray. This removes the possibility of scratching films by clips, and the needle holes do not admit enough light to be detected.

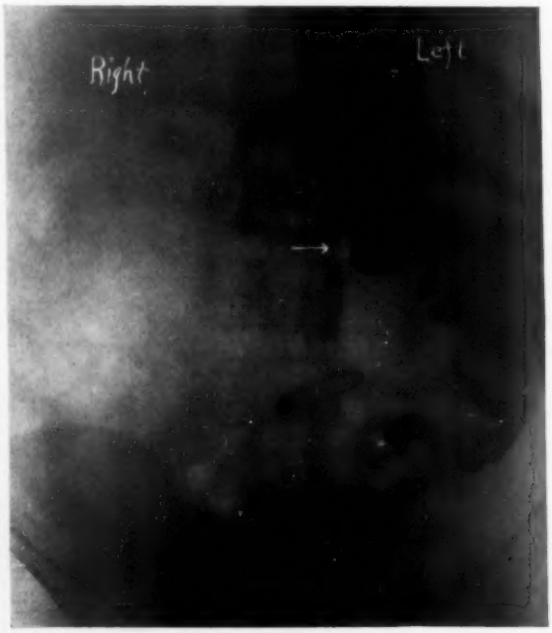
The films are mounted in two rows with incisor margins of teeth toward each other on a celluloid card with the emulsion side of film next to card so as to prevent curling of the corners. On each end of the card is designated right and left, so there can be no confusion as to the proper position. This serves as a permanent mount for films and greatly facilitates their interpretation.

LEFT-SIDED APPENDICITIS

BY JAMES T. CASE, M.D., F.A.C.S., BATTLE CREEK, MICH.

PATIENT male, age 57, gave a history of chronic abdominal discomfort, with occasional acute pains. On September 4th, 1914, not feeling well he went to an osteopath for treatment for a slight pain in the abdomen. A few hours later he had a very severe chill lasting half an hour, after which the temperature rose to 103. The family physician made a diagnosis of acute appendicitis and treated the case expectantly. The temperature gradually dropped and in two or three days it reached 99. September 10th, his temperature being normal, the patient made an automobile trip of about fifteen miles, after which his temperature gradually rose until it reached 101 degrees.

September 13th, the patient was moved to the Sanitarium Hospital and placed under careful supervision. Physical examination showed no tenderness on the right side, but on the left side, midway between the navel and the anterior superior spine of the ilium, there was a localized resistance, the size of the palm of the hand, coinciding with a point of very definite tenderness. The patient said that this was the spot where he had had tenderness all along. He was



COLON, TEN HOURS AFTER BARIUM MEAL, IN A CASE OF LEFT-SIDED APPENDICITIS, DUE TO CONGENITAL FAILURE OF THE COLON TO ROTATE.

placed in the surgical ward and watched for several days. When the patient was first seen the white cells numbered 30,000, but they steadily diminished, the temperature fell, reaching normal in about a week, and the area of resistance on the left side disappeared.

When I first saw the patient, the ninth day of his illness, I gave a colon injection with the opaque enema in order to identify if possible the point of tenderness. Just as was anticipated from the clinical findings, we were dealing with a case of left-sided appendicitis. The *x*-ray examination showed the colon to be incompletely rotated, the cecum being upon the left side. The lumen of the appendix did not fill. About a week later, after the patient's temperature had returned to normal, we gave a barium meal and the finding of incomplete rotation of the colon was again noted. The small bowel occupied the right side of the abdomen, while the colon lay entirely to the left of the midline, as shown in the accompanying roentgenogram, which was made ten hours after the ingestion of the barium meal.

An interval operation was recommended, but the patient declined it. A few months later while on a business trip, he was attacked with acute appendicitis and operated upon shortly after. The operating surgeon confirmed the diagnosis of left-sided appendicitis in a case of incomplete rotation of the colon.

WARTS AS A SOURCE OF ERROR IN THE SEARCH FOR CALCULI

BY JAMES T. CASE, M.D., F.A.C.S., BATTLE CREEK, MICH.

THE accompanying illustration is from a case of a wart on the back, the shadow of which can easily be seen through the transverse process of a lumbar vertebra.

The writer had heard doubt expressed as to the possibility of a shadow of a wart being recorded on a roentgenogram. It occurred to him that it would be of interest to exhibit the accompanying roentgenogram, which shows, at the arrows, very distinctly the shadow of a wart upon the skin. The origin of this shadow was abundantly confirmed by removing the wart and noting its subsequent absence in the roentgenogram; also, by placing the wart on another spot upon the skin and finding that the shadow had moved. This roentgenogram is of still further interest in that, in this particular instance, the shadow of the wart was projected in such a way that it showed even through the shadow of the transverse process of the second lumbar vertebra. The roentgenogram was made with the plate posteriorly, the patient lying supine, the tube anterior above the patient.

AT ARROWS THE SHADOW OF A WART UPON THE SKIN, SEEN THROUGH THE LATERAL PROCESS OF THE SECOND LUMBAR VERTEBRA.

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EDITORIALS

We recently heard a story related by one of our surgeons which illustrates the folly of expressing too positive an opinion from a single roentgenogram. The clinical history of the case was that the patient several years ago suffered from an acute attack of appendicitis, and came to operation. There was found a pus cavity, the appendix was removed, with a subsequent good recovery. After an interval of two years, the patient complained of some distress in the lower bowel, and was examined at one of our prominent institutions, where a plate was made which was thought to show an appendix. The patient was informed that he still had his appendix. Naturally he returned to his surgeon in a perturbed state of mind, and with some anger at the thought that he had been so deceived concerning his operation. The surgeon showed him the hospital record and the statement of several who were present at his operation.

Inasmuch as there was still an element of doubt, the patient decided to visit one of the surgical centers of America, where he was again examined with the roentgen ray, and a plate was produced which apparently showed the appendix still present. After seeing this plate, surgeon No. 2 delivered a lecture in which he condemned surgeon No. 1 for having left the appendix, and furthermore thought that the patient's present symptoms were dependent upon the fact that the appendix had been left at the former operation. Upon a second operation, the cecum was examined and there was found to be no appendix present.

The point of the story is that a diverticulum of the intestine had been mistaken for an appendix.

* * *

It is the ambition of many men to pose as all-round specialists, aiming to be proficient in surgery, medicine, and in all the different specialties. While this can be regarded with nothing but commendation, it is an ambition that no one can realize. In roentgenology, however, he who aims at excellence should be pos-

sessed of at least a modicum of this ambition, even though he falls far short of its realization.

The roentgenologist comes in contact with so many different phases of medicine, and so many different specialists that he needs to have a broad mind, with an adequate medical foundation and a zeal which keep him apace with the progress in all the various lines of medicine and surgery. His range of reading must be so extensive that he can discuss intelligently the differential points of diagnosis in the great variety of cases which are presented to him. As we heard it aptly put by one of our surgical leaders, a good roentgenologist must know as much about surgery as the surgeon, he should know as much medicine as the internist, and he should be thoroughly conversant with all the different specialties. If he is not possessed of the mental characteristics which make up a broad physician in a true sense, he will fall far short of producing the good which he might otherwise do.

While the various post-graduate courses which are being given in different parts of the country may profitably teach many of the technical points of roentgenology, without which no one can succeed, still the great school of roentgenology is the life study which its devotee must earnestly and seriously pursue. With the constant rapid advances in the different phases of medicine, the roentgenologist who does not constantly supplement his fund of knowledge with systematic and wide reading will soon lapse into a mere picture-taker. We feel that in no other branch of medicine is there such a wonderful opportunity for constant growth and the realizing of high ideals of perfection as in roentgenology.

* * *

A number of cases of poisoning with barium have occurred under such circumstances that it would seem well to utter a warning concerning prescriptions for its use. The cases of poisoning which have occurred have been where there was a confusion on the part of the druggist, either through misreading or misunderstanding the salt to be employed.

In one case under the writer's observation, which nearly came to a fatal ending, the physician in charge instructed the patient to take the powder the prescription for which he telephoned the druggist. The order for the druggist was barium sulphate; the druggist understood the telephone order to be barium sulphide. In another case recently, the roentgenologist, in a preliminary conversation with the attending physician, suggested that the patient be given two ounces of barium sulphate five hours before the examination. The attending physician wrote the prescription, which was so illegible that the druggist concluded that barium sulphide was meant. The druggist was protected in this instance, however, by the fact that he put a poison label on the package, but as the patient had been instructed by her family physician to take the powder, she did so, with very nearly fatal consequences. In another case which we heard about some time ago, the attending physician became confused between barium and bismuth, and ordered carbonate of barium for the patient, with fatal consequences.

Learning from these severe accidents the ease with which mistakes can be made, it would be well never to write a prescription for barium sulphate, but to administer the powder from a known package of a reliable pharmaceutical house, or else, if prescriptions are written, to use the bismuth salts. Inasmuch as the common bismuth salts are insoluble, it is much safer to prescribe them than to use barium. While there have been no recorded accidents from the use of barium sulphate, still the unpleasant consequences of the confusion of the barium salts should lead to the most painstaking precautions to prevent accidental poisoning.

DEPARTMENT OF *LABORATORY NOTES*

EDITOR, *David R. Bowen*, M. D., *Philadelphia, Pa.*

TELLTALE FOR HIDDEN COOLIDGE TUBES

BY GEO. C. JOHNSTON, M.D., PITTSBURGH, PA.

WHEN a Coolidge tube is employed for treatment purposes in a tube stand which completely encloses the tube it is very necessary to know whether the tube filament is burning properly or not or whether it is burning at all. Of course with an ammeter in circuit a glance at the meter will show whether or not the proper quantity of current is going through the filament; but where numbers of Coolidge tubes are in use, ammeters are frequently dispensed with.

We have had a great deal of comfort from the following device: A 14-volt carbon filament 6-candlepower Christmastree lamp is mounted in a small porcelain base and bridged across the 12-volt line going to the Coolidge tube. The 14-volt lamp is therefore in parallel with the 12-volt filament in the tube. When the current is turned off this little lamp is out, with the current on and the Coolidge tube filament burning properly, the little lamp merely glows, with the filament at a red heat. If, however, due to improper connection within the box, the Coolidge filament fails to take the proper amount of current or goes out, the little "telltale" flashes up to full candlepower and brilliant incandescence.

This brilliant incandescence is a danger signal and avoids subjecting invisible Coolidge tubes to high potentials when the filament is not burning. The lamp when burning dimly is a constant reminder of failure to turn the 12-volt current out of the Coolidge tube at the completion of treatment which, where many tubes are in service, will be found to be a rather common and expensive oversight on the part of assistants.

The total cost of the device is about 60 cents for each installation.

COMPRESSION DEVICE FOR STEREOSCOPIC EXPOSURES OF THE ABDOMEN

BY WILLIAM H. STEWART, M.D., NEW YORK

WHILE on service with Dr. Caldwell at the Presbyterian Hospital, we found it especially desirable at times to be able to examine stereoscopically both kidney regions on one set of plates; those who work as we did with the tube above are usually provided with a stand which is adjustable for stereoscopic work, but the tube can only be shifted by releasing the compression and raising the cone. This difficulty was overcome by the following simple device: a small wooden frame was built the width of which represented the inside space between the horizontal arms of the stand on which the tube

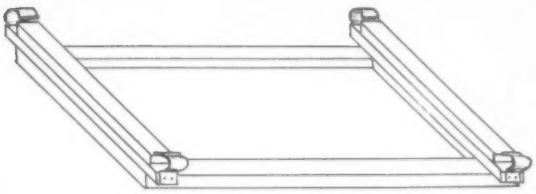

FIG. 1. COMPRESSION FRAME FOR EXPOSURES OF ABDOMEN.

holder slides. The length was sufficient to allow for the shifting of the tube and to give firm support while compressing the abdomen, about 14 inches. Across each end of the frame a wooden bar 5/8 of an inch thick, and the same width as the end of the frame, was provided; it extended out over the frame on each side sufficiently to receive the arms of the stand in hollowed ends. At each terminal of this bar was placed a metal clip which would snap over the horizontal arms of the tube stand and hold the frame in position. This frame was then windowed with transparent celluloid 1/8 of an inch thick.

Having snapped the frame into place on the arms of the stand, it was only necessary to inflate an ordinary No. B rubber football bladder, encased in a canvas bag, and, placing it on the abdomen of the patient, beneath the celluloid frame, obtain as much compression as desired, the tube holder being shifted the required distance above without disturbing the compression.

ILLUMINATING CABINET FOR ROENTGENOGRAMS

BY HENRY K. PANCOAST, M.D., PHILADELPHIA

IN our present cramped quarters in the Roentgen Laboratory of the University Hospital we were confronted by the problem of installing an adequate plate illuminating cabinet for the display of a large number of negatives in a very limited space. With the aid of my technical assistant, Mr. Jamieson, and some advice from a carpenter who had done considerable work of this kind we were able to devise a very satisfactory cabinet upon which can be placed at one time ninety-six 10 x 12 and forty-eight 14 x 17 plates, or of course a much larger number of smaller ones. This cabinet occupies a floor space of about four by twelve feet. Unfortunately it occupied nearly one-half of a small room, and we were unable to obtain a photographic reproduction showing it in its entirety. Practically the whole length is shown, but only about one-half the depth.

The length over all is eleven feet nine inches, the height seven feet seven inches, including a six-inch crown, and the depth fifty inches at the bottom and thirty-three inches at the top, not including the molding. It is built of poplar and beaver board, and a carefully applied mahogany finish has made it not an unattractive piece of labora-

FIG. 1. ILLUMINATING CABINET FOR ROENTGENOGRAMS.

tory furniture. The entire cabinet is supported by nine 3 x 4 legs, six of these being near the front, under the sash track floor, A, in order to support the major part of the weight. The top is supported by six 3 x 3 posts, B. It will be noted that there are two parts to the cabinet, one end being the illuminated portion, five feet six inches wide, and the other the storage portion, into which the sash are pushed when not in use. There are eight sash, each five feet, five and one-half inches high by five feet seven inches long. They are solidly constructed of inch and a half poplar, which allows ample space for two grooves, one for the glass, which may be clear or ground, and the other for the plates in front. Each sash is provided with a handle so that it may be moved readily, and with holders for name cards, C. The track floor, A, which must be rigid, is built of inch and a quarter planks and is twenty inches wide and extends the whole length of the cabinet. It is twenty-one inches high, this being a suitable height for one to be seated while studying plates. The iron tracks are screwed to the track floor along the entire length. In the bottom of each sash are ball-bearing runners, set *perpendicularly* in order that they may run evenly along the tops of the tracks. At the top, the sash lean backward against hardwood guides. The tracks are placed one and three quarter inches apart between the center of each. The first track is placed six inches from the front edge of the track floor.

The space back of the track floor for the lighting is twenty-eight inches deep at the bottom and eleven and three quarter inches at the top. The floor of this space is several inches below the track floor, and the roof is several inches above the sash guides at the top, to allow space for concealing the lights. At present we are using six 100-Watt nitrogen lamps with various types of reflectors which throw the light against a white background. The bottom of the light space is made of flooring so that one may walk in through the door, D, and along the entire length of the cabinet to arrange the lighting when necessary.

In order to save weight, the roof, the back, and the front of the sash storage portion are made of beaver board. Two racks, E, are attached to the front of the storage end for holding the envelopes of the plates on the sash.

This cabinet may be used for study of all the plates made during a day, or more particularly, as is our custom, for the study of gastro-intestinal plates, each sash being capable of holding the usual set of plates for an individual case. As the plates for a certain patient are made each day, they are placed on the sash upon which is found his name card. In this way each case can be studied or demonstrated by pulling out the sash which bears the patient's name.

DEPARTMENT OF TRANSLATIONS & ABSTRACTS

EDITOR, *James T. Case*, M. D., *Battle Creek, Mich.*

EGAN, ERNEST: The Fate and Effect of Hot and Cold Beverages in the Stomach. (*Muench. med. Wchnsch.*, Vol. 63, No. 2, Jan. 11, 1916, p. 37.)

Experiments were made with an opaque, non-sedimenting liquid, the properties of which are not impaired by temperature. The mixtures were introduced into the stomach at varying temperatures, but owing to the rapid equalization of temperature in the stomach, observations were confined to the first few minutes after ingestion. The results were in direct contradiction to the opinion formerly held that extremes of temperature did not influence the propulsion. In some patients, the liquids, immediately upon arrival in the empty stomach, flowed into the duodenum without any visible gastric action; in others, the evacuation took place immediately the stomach was filled; in others again the liquid remained for a time in the stomach sufficiently long to equalize the temperature before it was slowly propelled by subsequent peristalsis. These three variations were found in pathological as well as perfectly healthy subjects.

These three types of evacuation were not changed by varying the temperature of the beverage, the latter arriving at the intestine at the same rate of speed at any of the three temperatures. In all the cases with spontaneous evacuation, and in all those where evacuation took place after the stomach was filled, both hot and cold drinks left the stomach at a time when no equalization of temperature could have taken place.

In a few cases, both healthy and sick, the cold liquid caused very deep peristaltic waves leading to almost complete constriction, while the warm liquid produced only shallow peristalsis in the same individuals. Repeated examinations showed the same result in empty or practically empty stomachs. In some cases the deep constrictions were at once arrested when a warm dose was injected. When, however, a second cold dose was administered, the constriction persisted. On the other hand, the shallow waves occurring after a warm dose were not appreciably deepened by a second, though cold drink. Warm beverages never caused constriction as deep as cold ones.

Two cases behaved differently from the rest, cold drinks causing in-drawing which could not be observed after warm or indifferent drinks. In one of these cases there were suddenly prolonged shallow retractions at various places after peristaltic rest which deepened after a while without showing any progress of the wave. The other case showed, aside from deep peristaltic waves, a short deep retraction high up at the greater curvature, which persisted for a longer time than the shallow retractions of the previous case. It did not seem to participate in the progress of the peristaltic waves, but was always visible at the same place (stagnant wave).

Finally, there were cases which in this respect, too, were indifferent to the various temperatures.

KAST, L.: Effect of Fatigue upon Gastro-intestinal Motility. (*Proc. Soc. Exper. Biol. and Med.*, 1916, XIII, 79.)

The following paragraphs referring to Kast's article are taken from the editorial columns of a recent number of the *Journal of the A. M. A.*:

The movements of the alimentary tract are regulated not only by local nerve centers in the walls of the canal itself, but also through impulses which arrive from the central nervous system. In this way many influences which may even in part be conflicting in their effect can play on the gastro-intestinal tract at the

The Abstract Editor is indebted to the *Zentralblatt für Röentgenstrahlen, Radium und verwandte Gebiete* for material aid in the production of abstracts of many of the foreign articles.

same time. With the possibility of disturbing influences coming to portions of the intestine either reflexly through the central nervous mechanism or from other parts of the digestive apparatus, it is not surprising that discrepancies have arisen in regard to the interpretation of the motor phenomena. Observations of the gastro-intestinal motility by means of roentgen examinations, which leave the organism intact and are applicable even to man, have a decided advantage, therefore, whenever it is desired to consider the general effect of any condition on this function.

This lends a special value to Kast's recent study of the effect of fatigue on gastro-intestinal movement. Fifty-four individuals were kept on a standard diet for a number of days, and the motor efficiency of the stomach and intestines was determined repeatedly by a combination of the roentgen method, the use of the stomach tube, and the administration of carmin to determine the period of transit of food residue through the bowel. By taking the average, it was determined how long it took the intestines to propel the given amount of food. During the period of tests, the amount of physical activity was markedly increased or decreased, and the effect on the evacuating power of the stomach or intestines observed. At other times, without change in the diet or the amount of physical exercise, the amount of mental effort was markedly increased or decreased, and the effect observed in the same manner. Summarizing the results of such experiments, it appears that the healthy individual showed very little variation as regards the evacuating power of the stomach or intestines as long as the physical exercise was not excessive. Mental efforts had no perceptible effect. In patients with moderate and marked degrees of atony and splanchnoptosis, the evacuating power of the stomach and intestines decreased in direct proportion to the amount of mental and physical exertion. Physical exertion had the same effect in such individuals if the patient was kept in a horizontal position during these exercises and during the period of observation in order to eliminate the effect of splanchnoptosis in the erect position. In patients who clinically appeared susceptible to the effects of fatigue, mental exertion was more marked in its delaying effect than physical exertion.

CAILLÉ, A.: Foreign Body Pneumonia. (*Archives of Pediatrics,* Vol. XXXII, No. 12, Dec., 1915, p. 881.)

The author reports three cases of foreign body pneumonia. The cases are interesting, and in all the *x*-ray rendered valuable service, not only in diagnosis, but in the treatment. Bronchoscopy without the guidance of the fluoroscope was unsuccessful in every case, but in connection with fluoroscopic guidance, finally succeeded. Without the proper diagnosis, these cases in all probability would have been rendered with the verdict of death from pneumonia.

The author closes his article by expressing his belief that all foreign body cases should be duly reported in the lay press as a warning to those having charge of young children to keep things out of their reach, and not to teach them dangerous habits by direct suggestion. Mothers and nurses in many cases have a habit of holding safety and stick pins in the mouth, thus teaching this dangerous practice to their children by suggestion.

PETERI, IGNAZ: Roentgen-ray Examination of the Large Intestine in Infants and Children. (*Jahrb. f. Kinderheil,* August, 1915. Ref., *American Journal of Obstetrics.*)

Peteri discusses the value of the *x*-rays in the diagnosis and examination of the large intestines in children. He believes that much light can be thrown on the topography and function of this organ by means of the *x*-rays. Since bismuth in large amount may prove harmful to infants, other materials have been tried for the purpose of tendering the intestines visible by the rays. The author uses thorium. In order to make the thorium enter the intestine a large amount must be fed to the child, which it is difficult to make him swallow. The author introduces it by the rectum. He uses bismuth subnitrate and carbonate, zirconium oxy-anhydrid, with thorium oxy-anhydrid and barium sulphate suspended in a liquid. The colon must be entirely filled and the fluid retained in place by an obturator while the rays are being used. In spastic obstipation the colon is sure to be contracted. The rays assist in making a diagnosis of the form and location of abnormalities of the in-

testine, dilatation, and diaphragmatic hernias. It shows numerous normal variations in the conformation of the colon. It also gives the opportunity of observing the function of the colon, the peristalsis, antiperistalsis, and other muscular contractions of the bowel. There are three sorts of movements of the colon—small movements, which bring about the mixing of the contents; retrograde movements; and gross movements, which cause the feces to pass rapidly down the intestine. The author's observations deal with twenty-eight children.

FREEMAN, ROWLAND G.: The Value of the X-ray in Intrathoracic Lesions in Children. (*Archives of Pediatrics,* Vol. XXXII, No. 12, Dec., 1915, p. 891.)

A number of careful observers seem to believe that the *x*-ray is of little value and causes mistakes in diagnosis. Freeman believes that the men who hold this opinion have never been able to make free use of a well-equipped laboratory presided over by an expert roentgenologist. Disappointment in the use of this means of diagnosis may result from expecting too much from it. Alone, it is sometimes of limited value, but, like other evidence, in combination with clinical history and physical signs, it may be conclusive.

Auscultation, our most valuable means for determining the character of intrathoracic lesions, is of materially less value than auscultation in combination with percussion, and auscultation and percussion aided by a good *x*-ray plate may fix a diagnosis that might otherwise remain obscure, for the x-ray may show us lesions in the chest of which we can obtain no knowledge by any of our means of physical examination.

The *x*-ray is probably of most value in making the diagnosis of miliary tuberculosis, often in determining a pneumonia of which we get no physical signs, in making a differential diagnosis between empyema and pneumonia or in corroboration of a diagnosis of diaphragmatic hernia, while in lesions of the heart it furnishes reliable information as to enlargement, in the modification of the shape of the heart, in dilatation or the presence of exudate, and will often differentiate for us plastic exudate from fluid.

Concerning its use in the diagnosis of miliary tuberculosis there is probably more accord than concerning other conditions, for we all know that the physical signs of miliary tuberculosis in the lungs are those only of a slight bronchitis. We see repeatedly children with a temperature, sibilant and sonorous râles, sometimes subcrepitant, of the significance of which we can get no definite estimation without the *x*-ray. A von Pirquet test, if positive, will render the diagnosis of tuberculosis more probable, but still leaves us with the possibility of a simple bronchitis in a child with a tuberculous lymph node somewhere in the body. Having, however, obtained a characteristic picture by *x*-ray, we no longer need to speculate on the lesion present.

In diseases of the heart in children the *x*-ray gives us, Freeman believes, a most valuable indication of the amount of damage to the heart by the size and shape of the heart shadow, and successive pictures provide us with one of our best means for the control of exercise in these cases. For such control, of course, the temperature and pulse rate are of great value, but the *x*-ray picture will occasionally change our method of treatment to the advantage of the patient.

Enlargement of the thymus, and of the bronchial and mediastinal lymph nodes, and diaphragmatic hernia may also be brought out by the use of the *x*-ray.

The author concludes by remarking that the *x*-ray furnishes a most important means in reaching a definite diagnosis of intrathoracic lesions. It should not be neglected in any obscure case. It is particularly adapted to children, as one can get a better picture of a child usually than of an adult, and because children, even when sick, can easily be carried to an *x*-ray laboratory.

AMBERG, EMIL: X-ray Diagnosis of Mastoiditis. (*The Laryngoscope,* Vol. XXVI, No. 1, Jan., 1916, p. 7.)

The author of this article certainly pays a tribute to the assistance afforded by the *x*-ray examination of the mastoid. After citing fourteen interesting cases, Amberg gives the following summary from the literature:

Politzer remarks (Textbook, 1908) that *x*-ray examinations are indicated in the following pathological processes: (1) Foreign bod-

ies (projectiles). (2) Injuries (fractures of the base). (3) Malformations. (4) Hyperostosis. (5) Destructions: by inflammatory processes, cholesteatoma, sequesters or tumors. In the latter it is especially important to see whether they reach the dura of the middle or posterior cranial fossa (resp. the sinus). H. E. Kanasugi differentiated with the aid of roentgenoscopy the pneumatic from the diploëtic mastoid. He confirmed Politzer's findings that small and short mastoids show a diploëtic structure and large mastoids a pneumatic structure and that a favorable relation concerning the location of the lateral sinus exists in pneumatic mastoids.

We assume that as a rule the mastoid processes are similarly constructed on both sides. Speaking under the heading of (A), In Health: (2) The Interior, Cheatle says: "Classification of types is found on the conditions of the outer antral wall and mastoid process. In referring to the mastoid process, the terms 'upper and lower mastoid' are used, the 'upper mastoid' being the bone below the level of the apex of the antrum down to the upper level of the projecting part or 'lower mastoid.' On this basis it is found that of the 120 sets, 82 are symmetrical and 38 asymmetrical. In many of the asymmetrical bones there is a tendency to symmetry. It may be here stated that there are very few cellular bones without remains of diploë, either as a small mass at the extreme tip of the mastoid process, or as a rim around the tip."

Some changes in the roentgen picture may be expected in any middle-ear suppuration but it seems not possible to differentiate sufficiently the changes which may be found in any middle-ear suppuration from those indicating more serious involvement. Therefore, the clinical symptoms are of paramount importance.

A negative *x*-ray picture of a patient with pronounced clinical symptoms must not be relied upon as excluding the seriousness of the affection and its complications.

FREUD, JOSEPH: A Case of Hernia Diaphragmatica Dextra (paraesophagea vera congenitalis?). *Med. Klinik,* Vol. XII, No. 8, Feb. 20, 1916.

The author reports a very interesting case in which the cardiac part of the stomach and the upper part of the pars media were situated above the right half of the diaphragm in the thorax; the lower part of the pars media and the pyloric part were high up in the left hypochondrium, and the visible communication between them apparently took place at the level of the hiatus esophagus.

The thoracic part consisted of two sacs, the larger on the right and the smaller, glove-shaped, on the left. The direct way into the gastric part of the cavum abdominis was obstructed by an eminence in the middle of the fundus of the larger sac opposite the esophageal lumen, causing both thoracic sections to be filled with ingesta. The employment of the direct way from the esophagus to the pyloric part was possible only after the two thoracic sacs were replete with food (in the erect position). As there was no peristalsis in either, and as the right sac, judging by its irregular basal contour, was apparently adherent at the base, the stomach was probably never entirely empty in the erect position. It was only when the eminence receded that increased internal pressure, elimination of the left pocket and accumulation of gas effected rapid and copious propulsion into the pyloric part.

According to the author, this is the second case of the kind ever reported.

HOXIE, GEO. H.: Thymic Disturbance in Adults. (*New York Medical Journal,* April 8, 1916, p. 676.)

A taxing problem from a clinical or pathological standpoint. In the course of his remarks, he states that the fluoroscope should be used to verify all cases where the percussion would indicate thymic enlargement. This is rather delicate work, depending as it does on our having our visual accommodation attuned to the dark room, and further on our familiarity with making out semi-opaque masses. The questions that should be kept in mind when we see a mass under the sternum are: 1. Does it have a movement of its own? 2. Does it have a definite form through which the bones are seen more indistinctly?

On the matter of motion we should try to make out the pulsation of the aorta and note whether this mass has a similar movement. If it does not, we have the patient pant with his

diaphragm (heckelin wie ein Hund Schutze) to bring out any motility different from that of the surrounding bones. He should also be made to swallow to bring out the motion of the thyroid.

Many cases show up the sternospinal region so obscurely that unless we look at the dimming of the bone shadows we are unable to outline any semi-opaque mass.

The plates are of less value than the fluoroscope because they cannot show these semi-shadows unless they happen to be made with just the right exposure and the right development. For this same reason, it is difficult to secure convincing prints of these cases. We must therefore depend chiefly on the fluoroscope for our *x*-ray study of patients where thymic hyperplasia is suspected.

QUIMBY, A. J., and WILL A.: Roentgen Treatment of Unresolved Pneumonia. (*New York Medical Journal*, Vol. CIII, No. 15, April 8, 1916, p. 681.)

The authors report four cases of unresolved pneumonia which derived great benefit from this treatment. The technique calls for the ordinary type of aluminum filter and a focus-skin distance of about eight or ten inches, giving from fifteen to twenty milliampere minutes. Exposures are from two to seven days apart. Usually two or three treatments have sufficed. The treatment is indicated at the end of five days from the time resolution should have begun, and it has been shown to be effective three months from the date crisis should have occurred.

SHENTON, E. W. H.: Rapid X-ray Localization. (*The Lancet*, March 11, 1916.)

Shenton describes a new method of ascertaining the depth of imbedded foreign bodies capable of demonstration by *x*-rays. Mechanicians are now at work evolving a simple and businesslike method of applying this system, and for this reason, he merely states the principle.

The tube is moved a short distance and the length of the excursion of the shadow of the foreign body is noted. The screen is now raised until this excursion has doubled itself. The distance the screen has been raised is the depth of the foreign body. The extraordinary ease with which this can be accomplished, and the fact that no measurements are required, except those given above, make this system the simplest and the best that the writer has ever come across. He hopes in a short time to be able to describe a piece of apparatus that will enable the depth of any foreign body to be ascertained in a few seconds.

LENSMAN, ARTHUR P.: Gastro-intestinal Conditions and Rheumatism. (*Northwest Medicine*, Vol. VII, No. 10, Oct., 1915.)

A powerful influence has been working in modern medicine to make the problem of rheumatism simpler and better understood. The time is passed when a hasty diagnosis of rheumatism can be made, salicylates given and the case dismissed. The etiology in each case must be investigated, and, if gastro-intestinal disturbances be found, a serious study should be made to discover whether there is (1) a focus of infection in the digestive organs, (2) a serious inflammatory disease of the alimentary canal or of the digestive adnexa (liver, pancreas), or (3) stasis of the bowel.

On these findings will depend whether the treatment will be medical or surgical. If medical you have a splendid armamentarium of remedial measures. The first consideration must be that the diet shall consist of fresh non-fermenting and non-putrefying food. Limit the starches and sugars. Avoid the rich seasoned proteins. In rheumatics with overweight a diet of restriction; in the poorly nourished, a generous diet. The bowel irregularity should be treated by proper diet, paraffin oil, rectal irrigation, hydrotherapeutic measures, massage. In a few cases, laxative waters may be necessary but must be given with caution. Very often bowel antisepsis is necessary. Then we may make use of salol, aspirin, Bulgarian bacilli, etc.

The sum and substance of advice from the gastro-enterologist's point of view comes to this: A thorough study of the cases properly grouped and identified; correction or removal of the digestive pathology present. Every symptom of indigestion, every interference with proper metabolism should be recognized and corrected. In doing this we prevent the growth of bacteria and the absorption of toxins. This means that particular attention must

be given to the digestive tract, to keep it in good condition in order to prevent gastro-intestinal conditions from becoming precursors of rheumatism of "obscure origin."

LEE, JOHN ROBERT: Removal of Intracranial Foreign Body Under *X*-Rays. (*Brit. Med. Jour.*, No. 2882, March 25, 1916, p. 447.)

A piece of shell having entered the skull of a soldier at about the middle of the left temporal region on September 25, a roentgenogram was taken on October 11. In the meantime, the superficial wound had healed. The picture showed depressed fragments of the internal table around a small hole in the middle of the left squama, and the shadow of a piece of shell about ½ x ¼ in. was seen on the plate, 1 in. behind the hole and 1½ in. beneath the surface. At operation, the shell could not be felt with the probe. Another roentgenogram on October 15 showed that the piece of shell had dropped further back in the abscess cavity into the occipital lobe. A probe being passed along the abscess track, a stereoscopic roentgenogram was taken, which disclosed the fragment in the occipital lobe ⅛ in. in front of the tip of the probe and ½ in. mesial to it. An electromagnet capable of lifting 14 lbs. was applied to a steel probe and held in position for a few seconds, but without success. It was then decided to try and remove the fragment under the guide of the *x*-ray screen. It was found that the fragment had been pulled forward by the magnet and caught in brain tissue. A crocodile forceps removed it.

This illustrates, aside from the use of the electromagnet, that bits of metal can be demonstrated fluoroscopically inside the skull, although the roentgen rays have to penetrate two layers of bone.

The patient was not under anesthesia and felt no pain except as the sharp edges of the fragment touched the edges of the superficial wound.

COOLIDGE TUBE EXPERIENCES: Royal Society of Medicine, Section on Electrotherapeutics, Session of March 17, 1916. President W. Ironside Bruce in the chair.

Dr. Knox opened the discussion. He said that the Coolidge tube possessed, among other advantages over ordinary *x*-ray tubes, the quality of extreme adaptability; it could be used continuously over long periods without risk of damage to the tube, with currents of any strength likely to be required for examinations. Four or five milliamperes could be passed through it continuously for many years. Care must, however, be taken to protect both radiologist and patient, and sittings should be of as short a duration as possible. This tube was an instrument of precision in advance of anything of its kind yet produced. It could easily be adjusted for use in various parts of the body, and could be so arranged as to give off rays of varying penetrative power. For single-flash exposures it constituted the ideal tube. He had been carrying out a series of experiments, so far of an elementary character, with the object of ascertaining the best working conditions for the tube in radiography and radioscopy. The tube was altered from "soft" to considerable "hardness" in a few seconds. He hoped it would soon be possible to standardize radiographic exposures, and to make some advances in the measurement of *x*-ray dosage. The chief merits of the tube were seen in therapeutic work; indeed, it would be difficult to conceive of any improvements likely to render it more efficient. Within reasonable safety limits, it could be used for many hours daily, and at the end of the day would continue its output of uniform radiations. One such tube used at the Cancer Hospital was worn out after 800 exposures; it was then repaired and still remained in use. The others used there had maintained their efficiency all through. Dr. Knox gave a full description of his investigations. The researches included both screened and unscreened rays, and their penetrating power into 4-inch thicknesses of beef. The tube made it possible to attack a deep-seated growth from all aspects, and thus as searching a treatment by *x*-ray was possible as was obtained by embedding radium. The advent of this tube, said Dr. Knox, had opened up many interesting fields for experimental research, and he hoped that doctors would combine in an endeavor to standardize *x*-ray exposures in therapeutic doses, a hope which the new tube seemed to justify.

Sir James Mackenzie Davidson exhibited some interesting pin-hole radiograms, and showed from experiments the great need of the

radiographer protecting himself when using the tube, as the rays were emitted from the back as well as the front.

Dr. G. Harrison Orton said he had used the Coolidge tube 14 months for deep therapy, and he did not think anybody who had employed it would revert to the ordinary *x*-ray tube. It saved an enormous amount of time, and without forcing matters or overheating it was possible to turn a pastille in two minutes. The tube could always be adjusted to any required penetration, hence an exact repetition of a dose could be given. He found it particularly good for epilation, and by giving two separate 10 x doses, with an interval between, dermatitis was avoided. In starting with a new Coolidge tube only about a 4.4 ampere current should be used until the anticathode became properly hot; otherwise there was apt to be sparking outside, and the tube was not absolutely constant until then. When in working order the tube required no cooling mechanism.

Dr. N. S. Finzi spoke of his clinical experiences with the tube. He was not sure that the tube yielded the best results in delicate detailed radioscopy, as compared with the ordinary tungsten target. For bismuth-meal radioscopy the Coolidge tube was ideal. For radiotherapy with the Coolidge tube he had been trying to get the exposure down to the shortest efficiency period. He had been able to epilate a whole scalp in five areas well within half an hour. Each exposure varied from 48 to 54 seconds. He agreed with Dr. Harrison Orton that no one who had used the Coolidge tube would care to go back to the ordinary tube. He preferred the Wehnelt brake to the mercury brake.

Dr. C. W. S. Saberton spoke of a daily experience with the Coolidge tube for eight or nine months. He had not obtained such good negatives with this tube as well as with the ordinary *x*-ray tube, but the type of rays emanated was uniform in the case of the former. In tinea cases his experience was not the same as Dr. Harrison Orton's; he required a larger dose to produce epilation. He advocated the measurement of dosage of *x*-rays after filtration.

Dr. S. Russ remarked that Professor Rutherford and his colleagues found they could not produce *x*-rays of such short wave-length as the gamma rays of radium, the ratio being as 1.7 to 0.7. The difference in the radiographic results from ordinary tubes as compared with those of the Coolidge tube noticed by Dr. Finzi was probably due to the fact that the radiations came in one case from the whole stem of the anticathode. He felt that radiographers and physicists owed a great debt of gratitude to Mr. Coolidge for his invention, which he regarded as the most wonderful *x*-ray tube which had ever been constructed, and that much more would be revealed by it in future.

Dr. Knox briefly replied.

RUH, H. O.: Acrocephalosyndactylism—A Teratological Type. (*American Journal of Diseases of Children*, Vol. II, No. 4, April, 1916.)

The author describes a case seen by the Pediatric Department of the Western Reserve Medical School. The cranium shows a marked lengthening in the external distance from the nasion to the inion. The anteroposterior diameter is greatly shortened. The superciliary ridges are highly arched and flattened and the brow bulging. The orbits are also flattened anteroposterially, which, together with the deformity of the superciliary ridges, causes a marked proptosis. There is not infrequently found a sulcus or ridge in the situation of the metopic suture. In general, the head is symmetrical. The facial bones are profoundly altered. The zygomata are very prominent, the root of the nose depressed (saddle nose), the superior maxillæ atrophic, causing the right and left alveolar borders to be pressed together, thereby forming one of the most characteristic features, namely, the very highly arched palate. In fact, this is sometimes so narrow as to give the appearance of a cleft. In those patients that have lived to a sufficient age there has been anomalous dentition. The neck, chest and abdomen show no pathologic changes. The extremities are markedly deformed by the presence of a more or less complete syndactylism. The hands are semiflexed, and the palms are immobile. The thumbs are mobile and generally not involved in the syndactylism. Various kinds of anomalous ossification have been mentioned. Probably the most constant deformity has been the fusion of the fourth and fifth metacarpals at

their bases. Reduction (oligodactylism) and increase (polydactylism) in the number of the phalanges have been described, as well as the absence of the terminal phalanges (bradydactylism). The feet show anomalies similar to those in hand.

Roentgenographic studies have been published in six cases—Fournier, Maygrier, Dubrisay, Davis, Bertolotti, and in our own case.

The condition is compatible with life. The ages of the described patients vary from newborn babies (Dubrisay and Fournier) to 31 years, as in the cases of Galippe and Magnan. The mental activity varies, but in most cases it is stated to be normal.

MASON, HOWARD H.: Lobar Pneumonia in Childhood. (*American Journal of Diseases of Children,* Vol. II, No. 3, March, 1916.)

During the past two years all cases of lobar pneumonia on the Children's Service at the Presbyterian Hospital have been roentgenographed at least once. In those cases showing a shadow, but in which bronchial voice and breathing were not heard, repeated roentgenograms were taken at varying intervals. The purpose of these examinations was to ascertain whether the consolidation as evidenced by this shadow passes through any regular development, and if so, whether the different stages of its progress can be correlated with the development of certain physical signs.

From these cases, thirty-seven were chosen in which lobar pneumonia was uncomplicated. These all showed definite shadows, which were always quite dense and uniform, and usually definitely outlined. In every case the shadow was so situated that the consolidation must touch the pleura at some point. One patient, however, did not show a shadow five hours after the initial chill. A second negative was taken on the third day of his illness and showed a typical dense shadow. Two patients who developed lobar pneumonia while in the ward, were roentgenographed on the second day of fever, and both showed definite shadows at this time.

Of these thirty-seven cases, fifteen showed in the first roentgenogram a uniformly dense shadow extending over all or almost all of at least one lobe, thus making it impossible to tell where the shadow first appeared. The first negatives of seven cases showed median shadows. In these cases also it was impossible to say how deep the consolidation extended. In both groups the shadows touched the pleura at some point. In thirteen cases the shadows were lateral, and it is the further development of these shadows that I wish to consider. At first they were always triangular in shape, with the base on some portion of the periphery of the lung and the apex directed towards the root of the lung. The most frequent site of the base of the triangle was opposite the upper part of the axilla. From day to day they usually spread upward and downward toward the root, gradually increasing until just before the crisis. Occasionally they spread on the surface of the lung but not towards the root. In the early stages there was a relatively clear area between the apex of the shadow and the root of the lung. As the shadow spread it obliterated this clear area, until in most cases there was a uniform dense shadow extending from the lateral surface of the lung to the root.

That is to say, in the beginning of the process there is a triangularly shaped shadow with its base on some portion of the lung periphery and its apex pointing toward the hilum. This shadow is separated from the root by normal lung shadow. Gradually the triangular shadow spreads up and down and towards the root into the norml area, until, as a rule, most of one lobe is involved. In trying to visualize the nature of the anatomic change in the lung, Tripier's description helps us. At first there is a small conically shaped consolidation, the base of the cone lying in the plane of the lung periphery and the apex of the cone pointing toward the hilum. This cone of consolidation gradually becomes larger and larger until finally its apex reaches the hilum and its base coincides with all, or with a large part, of the pleural surface of the lobe. The process seems, therefore, to begin in that portion of the lung which is anatomically farthest from the hilum, that is to say, that part of the lung which lies close to the pleura. To be sure, the early consolidation may lie along the mediastinal pleura, or the diaphragmatic pleura or the pleura of an incisure. The fact which it is desired to emphasize is that the consolidation always begins in that portion of the lung which lies close to the pleura. Such a consoli-

dation, when situated on the mediastinal or diaphragmatic surface of the lung may be separated from the chest wall by normal air-containing lung and in this sense may be central. On the other hand, this conception is not the same as that usually understood when so-called "central pneumonia" is spoken of, the term central pneumonia being in this sense restricted to consolidation which does not touch the pleura at any point. Weill and Mouriquand agree with this point of view when they say that they have never seen a shadow that could be interpreted as due to a central pneumonia.

The shadows above described and the anatomic changes which they indicate suggest the explanation for the occurrence of certain physical signs with which we are familiar.

In all of the fifteen cases that gave dense shadows extending from the lateral surface of the lung to the region of the root in their first roentgenograms, there were bronchial voice and breath sounds. Thirteen cases showed only lateral shadows at the first examination and in none of these were bronchial voice and breath sounds detected. Ten of these patients were examined again later, when additional roentgenograms were made. Eight of the ten developed bronchial breath and voice sounds later. In all eight cases these signs did not appear until the shadow extended to the region of the root. The shadow in the two cases that did not develop bronchial signs did not extend to the hilum, but the shadow in these cases was always separated from the root by an area of normal lung shadow. Unfortunately no subsequent roentgenograms were made in the remaining three cases.

In all these cases bronchial voice and breath sounds were present when the shadow extended from the lateral surface of the lung to the region of the root, and they were absent when the shadow was separated from the region of the root by an area of normal lung shadow.

There can be little doubt that those cases with continuous shadows from the lateral surface of the lung to the region of the root, have corresponding areas of consolidation. These facts furnish an explanation for the presence of bronchial signs. Bronchial breath and voice sounds are normally present over the trachea and large bronchi, but they are not conducted to the rest of the chest. In the first case, the sounds traverse solid tissue of a comparatively uniform density with little loss in quality or change in intensity, while in the latter case they pass through many layers of tissue and air of altering density, the repeated changes from air to tissue being accompanied by loss of the original quality.

When the medium is uniform, therefore, there is bronchial breathing and voice. If, however, the consolidated lung extends only part way from the stethoscope to the hilum, the loss in quality is great, and the breath and voice sounds are not bronchial.

WESSLER, H., and BASS, MURRAY H.: Recurrent Hilus Infiltration. (*American Journal of Diseases of Children*, Vol. II, No. 3, March, 1916.)

The work of Hamburger, Ghon, Albrecht and others has proved that in the majority of instances tuberculosis enters the organism by means of the respiratory tract and at first localizes in a small, often almost microscopic lesion in the lung tissue itself. This focus, varying in size from that of a pinhead to an almond, is termed by Ghon the primary focus. This has been found in practically all the cases giving a positive von Pirquet reaction. Secondarily from this lesion, the bronchial nodules become involved and form in all probability the nidus in which the latent infection lies dormant. The disease may remain permanently in this condition, the nodes finally organizing or calcifying; or else they may act as a starting point for further pulmonary involvement. This secondary involvement may be the outcome of either a reinfection, in which case the apical and phthisical forms result, or else direct extension from the lymph nodes may take place.

It is the author's purpose in this paper to report one particular variety of juvenile tuberculosis which is of considerable importance. This lesion occurs in the vast majority of cases on the right side, and its point of predilection is the lung in the immediate vicinity of the fissure between the upper and middle lobes. Beginning with its base at the hilus, where a dark shadow of tuberculosis nodes is visible, a fairly opaque shadow of homogeneous density extends outward into the lung for a considerable distance, gradually fading into the normal lung tissue. The resulting

infiltration is triangular in shape, its apex near the axilla. Its lower margin is sharply limited by the interlobar fissure. The latter is evidently thickened and is the seat of a pleurisy, as it can usually be seen extending quite to the axilla beyond the limits of the infiltrated area.

Various interpretations have been applied to these shadows. They have been assumed by Eisler to be to a great extent due to pleurisy in and about the interlobar fissure, resulting from a primary tuberculosis focus in the sense of Ghon, which is so frequently found at necropsy in this situation. Sluka, on the other hand, and with greater plausibility, believes that it is a direct infection of the pulmonary tissue from the caseated lymph nodes at the hilus with a resulting tuberculosis infiltration of the lung.

Most forms of tuberculosis as we encounter them in adults are characterized by the constancy of the findings over fairly long periods of time. In these cases, the process suffers striking variations in its extent. The roentgen examination made at intervals of a month may show at first a wide area of infiltration and at the later examination, nothing may be left but the thickened interlobar fissure. The latter usually persists for a long time as a thin, sharp line running horizontally across the upper part of the right lung from the inner end of the fourth costosternal junction to the axilla. Such a sequence of infiltrated and normal lung may be repeated several times, and justifies the appellation of "recurring hilus tuberculosis," and will find its correspondence in the signs and symptoms of the patient.

The fact that such regressions not only in the symptoms, but also in the roentgen-ray findings, can take place also needs explanation. It is difficult to conceive of a true tuberculous infiltration coming and going in this fashion, and the most plausible theory appears to be that the underlying pathologic process is one of an inflammatory exudate about the tuberculous hilus. Such exudative processes have been described by Fraenkel, who ascribed them to toxin action and showed that they might resolve, leaving very few traces behind them.

O'Brien, Frederick W.: The Present Status of Gallstone Diagnosis by the Roentgen Ray. (*The Boston Medical and Surgical Journal*, Vol. CLXXIV, No. 9, March 2, 1916.)

This is a summary of the literature concerning roentgen diagnosis of gallstones. He concludes his remarks by stating that with a proper technique and tireless effort, gallstones can be shown roentgenographically so much more often than formerly that the intimate coöperation of the profession should be solicited for the perfecting of this diagnostic aid.

The proof of the pudding is in the eating. The ideal would be to have a surgeon or group or surgeons submit their cases that are to be operated upon, irrespective of what may be the roentgen findings. In this way we should soon learn whether or not we have in the *x*-ray an infallible guide—infallible as anything wherein enters the personal equation can be—in gallstone diagnosis.

BOOK REVIEWS

EDITOR, *Edward H. Skinner*, M. D., *Kansas City, Mo.*

CANCER OF THE STOMACH BY FRANK SMITHIES, M.D., Gastro-enterologist to Augustana Hospital, Chicago. With a Chapter on the Surgical Treatment of Gastric Cancer, by Albert J. Ochsner, M.D., Professor of Clinical Surgery in the University of Illinois. Octavo of 522 pages with 106 illustrations. Philadelphia and London. W. B. Saunders Company. 1916. Cloth, $5.50 net; Half Morocco, $7.00 net.

In the third paragraph on the first page of Smithies' text we find a most gracious acknowledgment of the ability of the roentgen ray to assist in the diagnosis of gastric carcinoma. But at several other places in the book there appears to be almost a studied attempt to minimize roentgen ray values. For instance, upon page 268, "It is well to admit that much of the positive information which x-ray examinations give us concerning the function or abnormalities of the stomach can be as well obtained by routine clinical examination."

Also, "In the large majority of instances, x-ray findings only concern what might be termed accidents in the progress of the disease process." When speaking of the serial roentgenographic examination, Smithies says, "In admiration of the perfection of these contrivances one may readily lose sight of the fact that the information they return to us has little actual worth."

In the concluding paragraph of Smithies' roentgen chapter we find that "The plates form, however, an interesting accessory record to the histories, and aid in the selection of cases likely to be benefited by surgical procedures, by indicating roughly the location of the growths and the extent that they invade the gastric wall or involve other viscera."

If the author thus minimizes the x-ray examination he undoubtedly depends upon his case history and chemical analysis. It has not been long since the chief of a large and popular clinic, where intimate chemical analyses have long been established, stated in various places in medical literature that the essentials in gastro-intestinal examinations were no longer rated as 1, Case History; 2, Chemical Analysis; 3, Roentgen Findings; but were now rated as, 1, Case History; 2, Roentgen Findings; 3, Chemical Analysis. And it becomes more apparent each year as chiefs of large surgical clinics secure competent roentgen assistants, that the x-ray findings are relatively more accurate than test-meals. Obviously, the case history is the paramount issue.

There is no doubt but that Smithies' chapters upon Symptomatology, Examination of Gastro-Intestinal Function, etc., are replete with the standard facts as they have been known and with original knowledge which must accrue to the individual who has had the opportunity of studying 921 operatively and pathologically demonstrated instances of gastric cancer. The mere deficiency of the roentgen chapter does not detract from the book's value to practitioners. We would have been better pleased, however, if it were not for the author's indifference to x-ray findings. It cannot be that this seeming prejudice is based upon lack of interest. Rather would we suspect that the author has not had the advantage of a modern roentgen laboratory or the sympathetic collaboration of a competent roentgenologist. We will grant that a clinician may become so proficient in gastric-intestinal chemistry that, added to the careful history, this is 90% perfect. On the contrary, we believe that the same clinician, with competent roentgen knowledge, and his case history, can equal or surpass the above percentage. How much better it would be in a book purporting to totalize our present knowledge of Gastric Cancer, to present as careful an analysis of roentgen values as it seems to present upon the chemical analysis.

MEDICAL ELECTRICITY, ROENTGEN RAYS AND RADIUM WITH A PRACTICAL CHAPTER ON PHOTOTHERAPY BY SINCLAIR TOUSEY, A.M., M.D., Consulting Surgeon to St. Bartholomew's Clinic, New York City.

Containing 798 Practical Illustrations, 16 in Colors. W. B. Saunders Company. 1915. Philadelphia and London.

This encyclopedia of medical electricity has established itself as the ready reference book for the busy practitioner and the struggling beginner who may have been prevailed upon by the successful salesman to install some sort of electrical apparatus as a means of impressing patients and incidentally treating them. There is probably much electrical apparatus installed in physicians' offices that is rusting for lack of intelligent application. It is not due to the fact that electricity in medicine is of little value, but it is of little value to the patient because the physician does not know how to apply his electrical modalities.

Tousey's book should reawaken interest and take the dust off much unused apparatus. His descriptions of electrical methods are wonderfully complete. We have thought of odd random subjects to test this encyclopedia and have become impressed with its completeness, with the possible exception of the Roentgen chapters.

Especially are the pages on Electrodiagnosis full of clear descriptions and illustrations. Again we would call attention to the chapters on Ionic Medication, High Frequency Currents and Phototherapy. The chapters on the Physiological Effects of Electricity and Electropathology are extremely comprehensive. The latter carries much from Jellinek's recent monograph. This subject has become of great medico-legal interest since the establishment of electric circuits in towns has become almost universal.

We cordially recommend this book with no apprehension and feel assured that the purchaser will find information on any electromedical subject he may desire.